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ABSTRACT

A 1-year project was conducted to explore ways and suggest possible strategies by which Further Education staff in Great Britain can help improve women's participation, progress, and attainment in physical science and technology, particularly at technician and craft levels. Data were collected by a questionnaire survey of heads of science and technical departments in approximately 100 colleges and polytechnics in England and Wales. The survey sought to gather details of women's enrollments and efforts made by departments to increase women's participation rates, and the views of senior college staff upon issues which previous research has shown to have a bearing upon women's entry into science and technology and their subsequent progress. Based on this information, as well as on data gathered from case studies and literature reviews, a number of recommendations were made. These recommendations included departmental outreach activities, improvement of course and career literature, and use of female academic staff in order to raise girls' and women's awareness of the worth of science and technology occupations. Other strategies suggested were helping students to shop around for courses, increased attention to mature students, more help for women students in the transition from secondary school to college, and more introductory course content to help young women prepare for technical careers by providing background information which they may lack. (KC)

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Further Education Curriculum Review and Development Unit

PROJECT REPORT

BALANCING THE EQUATION

a study of women and science
and technology within Further Education

by Sheila M Stoney and Margaret I Reid

Report of a project commissioned by FEU from
The National Foundation for Educational Research

CE 033 162

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Preface by FEU

FEU priorities are concerned with examining areas of comparative neglect in further education. Insofar that this research report is about equality of opportunity and access to science and technology for women, it is highly relevant to those priorities and the FEU wishes to be associated with its findings.

The report seeks to examine and suggest ways in which FE staff can help in overcoming the low participation of women in science and technology and industry, especially at technician and craft level, and in encouraging progress and attainment within these non 'traditional' fields.

The research was especially concerned with curricular and teaching issues and their relevance to the central theme of the report, but also had to take note of and consider societal attitudes associated with science and technology and the role of women including cognitive and manipulative ability and other sex-stereotyping factors.

The research investigated the experience of Heads of Departments of science and technical departments in approximately 100 colleges and polytechnics in respect of women students; it surveyed initiatives made on behalf of women by training, validating, and professional bodies and other interested parties, and it carried out a literature review.

It makes comprehensive recommendations to staff on strategies for facilitating women's access to, and successful participation in, courses in science and technology departments including:

- maximising the use, as models, of women science staff who have been successful in entering science/technology fields
- improving departmental outreach provision and course and careers literature
- offering through introductory programmes, options and modules, a greater opportunity in the first year of any programme to sample and experience the various fields of science and technology
- providing access to remedial and tutorial opportunities especially in cases of lack of previous experience and 'practice deficit' in the case of manual skills
- ensuring that staff understand how individual learning needs may be supported, not only by careful ordering of curricular content, but also by using teaching processes which have relevance for, and allow participation of, the student.

Much of the work in the report is concerned with examining sex-stereotyping and its effects on the attitudes, expectations and apparent abilities of students, but the evidence suggests that although change may be difficult to make and slow to achieve, it is possible. The FEU believes that change is not only possible but necessary and that we can not afford to impede the education/training to the highest possible level of achievement of any group of individuals on grounds of their sex, ethnic origin, age or culture. It further believes that this report points up important issues, not only of equality of access to mainstream science/technology education and training for women, but also gives more general indicators for education and training strategies to cope with the changing economic, technological, industrial scene, its changing labour market and the consequent need for a more highly skilled, flexible workforce.

In the FEU response to Outlook on Training – Review of the Employment Training Act 1973; MSC July 1980, concern was expressed at the apparent inflexibility and inability of the present system to cope with changing technology, local manpower needs, and with the discontinuity between the education and training systems. The FEU also believes that the rather rigidly structured apprenticeship system with its highly specific content and long duration, together with a somewhat restricted age of entry should have been more seriously challenged in the Review.

We had serious doubts as to whether the pattern of initial training could remain the predominant mode of producing skilled craft-type manpower in a rapidly changing technological society. We agreed with the CPRS (Think Tank) Report 'Education, Training, and Industrial Performance, which suggested that the supply of a flexible work force would probably depend on carefully planned vocational education and training based on transferable intellectual and practical skills capable of rapid work-based orientation to specific job skills. In curricular terms this means a flexible and progressive structure of programmes at specified levels of competence, having a variety of entry points for school leavers and adults, at all levels.

The Finniston Report* indicated that less than half of one per cent of the current stock of engineers is women and while there has been some noticeable increase in women's participation within the main scientific professions their participation rate in technology courses has remained almost static. The MSC predicts that changes in the balance between the manufacturing and service industries will mean that by 1985 the number of white collar jobs will exceed blue collar jobs and that 'process' skills (which include the ability to handle people, data, and other information in a variety of ways, to plan, and to solve problems) will be more in demand than 'product' skills (which include the ability to produce artefacts using manual skills, and power tools). In engineering a shortage of skilled personnel is predicted at professional engineer, technician engineer and craft level. We cannot afford to deny these skills to half the population.

This report on access for women to non-traditional jobs, mirrors problems of access for other groups of workers to jobs which may be non-traditional for them and for which their previous experience and training has not prepared them.

Such groups include:

- redundant skilled workers retraining for occupational sectors which may not yet even have been fully identified
- craftsmen and technicians requiring to be trained as supervisors for middle management
- semi-skilled adults needing to become skilled if they are not to be unemployed
- low achieving school-leavers without much in the way of

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* Engineering our future: report of the Committee of Enquiry into the engineering profession. Cmnd 7794. HMSO 1980

academic qualifications who need to be offered education/training courses to enable them to maximise their potential.

In all these categories there are sub-groups with specific needs (women, the handicapped, ethnic groups . . .). The FEU considers that one aim of further education and training provision should be to produce a workforce which is flexible and skilled, having an ability to transfer those skills and to learn new skills when required. But the traditional FE system has little experience with the kind of students who are in the groups identified above, and it will need to develop new approaches to provide for them, the opportunities and access they require.

We consider that many ideas for such new approaches are to be found in this research report and that a number of them echo the curricular processes set out in our own report 'Vocational Preparation'.* These include:

- the importance of relevance, experience and participation for students in the learning process
- the need for guidance, counselling and sensitive assessment procedures both on entering and during a course
- some form of negotiation through an induction process which enables the learner with a tutor to identify his or her individual learning needs and the
- best way of fulfilling them by drawing up a personal learning programme
- a checklist of basic skills against which the learner's previous experience can be matched and deficiencies remedied.

The personal development and retraining of adults for new occupations are likely to become permanent features of FHE provision and it is essential that new learning models, curricular approaches, organisational/administrative structures and concomitant in-service training and staff development are found which can cope with this. This requires many changes in attitude, not least in the stereotyping associated with the ability of women.

It is hoped that this research report, and the earlier NFER report on Bridging Courses for Women*, not only help science and technology departments in colleges to develop their provision for women, but also provide curricular ideas and approaches relevant to the needs of all groups of 'non-traditional' students and thus help to 'balance the equation' of the opportunity, education and training. The report is recommended reading for all those interested in the developing role of FE as a provider for the training/education needs of the eighties.

Jack Mansell
Director FEU

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* Vocational Preparation FEU 1981.

* 'Further Opportunities in Focus' – FEU PR5 1980.

CHAPTER 1

The Project and The Problem

1.1 Introduction

The phrases 'woman engineer' and 'woman scientist' still make headlines in the papers today; their very newsworthiness implies that women who pursue careers within the fields of science and technology are departing far from the accepted norm, a statement which can be substantiated by a great deal of statistical evidence. It could be argued that only when the terms 'engineer' and 'scientist' cease to be prefixed by the word 'woman', when referring to females of these professions, will equal opportunities really exist within this area. The information available from many sources suggests that in 1980 we remain a considerable distance away from achieving the still controversial goal of women and men fulfilling comparable, if not altogether identical, roles in employment and society. This is all the more disappointing when one considers the high hopes held out for the early advancement of women into all sectors of working life in the years following the close of the First World War, some sixty years ago. These are described in the words of one writer* of the time:

'it was impossible to remain very long pre-occupied with the effect of the war upon one's own position when the opportunity of changing the position of women . . . was there to be seized for the first time in history.'

'the reorganisation of society in such a fashion that its best women could be both mothers and professional workers seemed to be one of the most acute problems which my generation – and to a lesser but still important extent all subsequent generations – had now to face.'

The aim of this report, however, is not to document yet again (other than is necessary to set the scene) the small numbers of women currently following courses and careers in the physical and applied sciences and industry. There is a vast and ever-increasing literature on this subject to which the reader can refer for information and commentary. Rather our overall intention has been to explore what if any measures can be taken within the Further Education Sector, with particular reference to curricular developments and modifications to teaching approaches, (a) to improve women's access into science and technology courses and ultimately careers, and (b) to promote, where necessary, their progress and attainment once they have opted for such non-traditional career routes.

An integral part of this task was to identify the main governing variables which influence women's educational and career-related decisions and endeavours and to explore their interrelationship. This work was completed in two ways. A review of the relevant theoretical and applied findings of researchers here and abroad was conducted, and this forms the basis for Chapter 2 of the report. Secondly, a questionnaire survey was carried out of Heads of science and technical departments within Further Education (reported in Chapter 4), which provided a viewpoint on the key issues from those who have to cope with the problem in practical rather than in theoretical terms. It is interesting to compare and contrast the differing perceptions of these two groups in Chapters 2 and 4. The questionnaire survey sought, not only to gather the views of senior college staff but also to collect up-to-date take-up data on students and to explore departmental organisation and curricular provision. From this information it was possible to assess the types of initiatives which were being made with regard to women students. The project did not confine itself to activities within the sample colleges but sought to discover what initiatives and policies were being made on behalf of women by other colleges and universities as well as by regional and national organisations whose sphere of influence lies within science and technology. The results of this survey of initiatives, which are described in Chapter 3, provides a third set of approaches to the problem and helps to set the college-based research in a wider context.

The early researches of the project revealed the daunting size and complexity of the problem at hand. The following is a list of variables which required consideration: attitudinal factors (various); innate cognitive variables; personality traits; educational and family backgrounds; parental, teacher, employer and peer-group influences; organisational aspects of primary and secondary schools; employment prospects; careers guidance provision and the dissemination of occupational information, in addition to curricular and teaching-related issues. It is clearly evident from this, therefore, that with regard to the question of poor participation by women in the fields of science and technology, Further Education is in the invidious position of inheriting a difficult problem which started much farther down the line. Moreover, the problem is not one which ceases at either some point in the educational system or in time but continues to be promoted by powerful influences which will be slow and difficult to change. Given this situation, however, our evidence does not indicate, as some would suggest within Further Education, 'that it is too late; there is nothing we can do at this stage'. One of the aims of the report is to offer insights and suggestions, albeit often tentative, as to how developments might be effected as well as to provide a source of information which will form a basis for discussion and help colleges, polytechnics and other organisations to develop their provision with the needs of women students more clearly in mind. In Chapter 5, which examines the curriculum, teaching and organisation of selected college departments in relation to their women students, attention is particularly given to such insights and to a discussion of the practical implications, from both the departments' and the students' point of view, of having women take advantage of opportunities within science and technology. For those who seek a summary of the project's findings and recommendations referral is made to Chapter 6.

1.2 Research Plan

This report is the outcome of a one-year research project which was conducted during 1980 by the NFER on behalf of the Further Education Curriculum Review and Development Unit. The study comprised three main elements as shown in Figure 1.1 which

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* Brittain, V. (1933) 'Testament of Youth', Virago Press.

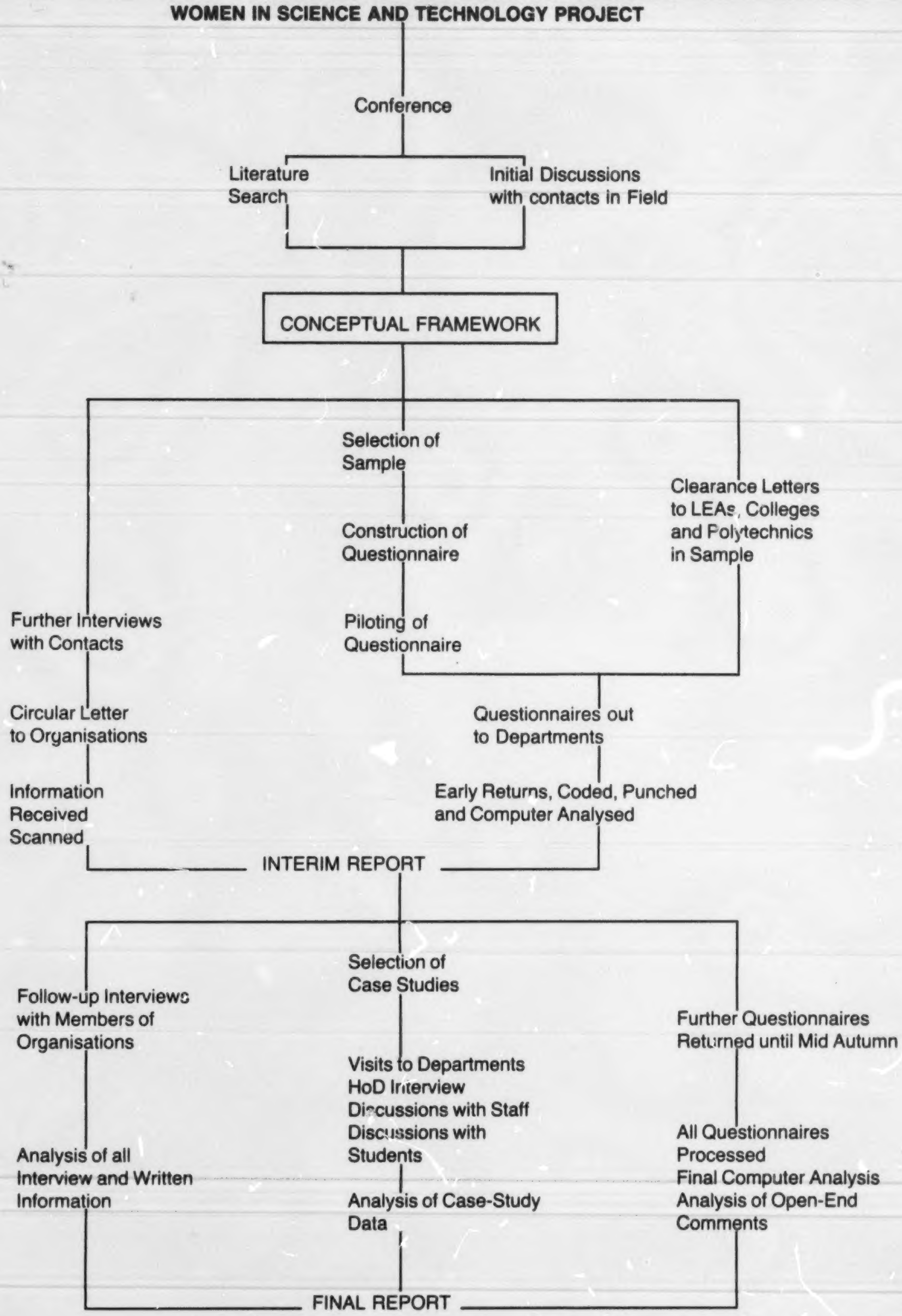
WOMEN IN SCIENCE AND TECHNOLOGY PROJECT
Conference
Literature Search
Initial Discussions with contacts in Field
CONCEPTUAL FRAMEWORK
Selection of Sample
Construction of Questionnaire
Piloting of Questionnaire
Clearance Letters to LEAs, Colleges and Polytechnics in Sample
Further Interviews with Contacts
Circular Letter to Organisations
Information Received Scanned
Questionnaires out to Departments
Early Returns, Coded, Punched and Computer Analysed
INTERIM REPORT
Selection of Case Studies
Follow-up Interviews with Members of Organisations
Further Questionnaires Returned until Mid Autumn
Visits to Departments
HoD Interview
Discussions with Staff
Discussions with Students
Analysis of all Interview and Written Information
Analysis of Case-Study Data
All Questionnaires Processed
Final Computer Analysis
Analysis of Open-End Comments
FINAL REPORT

Figure 1.1 Research Plan for Project

indicates the overall structure of the project.

Attendance at a conference whose theme was 'Sex Differentiation and Schooling'* in the early days of the research brought the project in contact with some of the foremost researchers in the field from both Britain and the United States. The opportunity was available to become acquainted with current thinking on the ways in which sex differences and stereotyping develop over the years of schooling and up until adolescence. It provided, in fact, a very useful conceptual starting point for the present research and highlighted the many facets of the problem which would require consideration. This prompted a closer examination to be made of previous research findings, and this was completed by an on-line search using the NFER's terminal to the ERIC** database in California.

The experience gained by these researches was utilised to devise the questionnaire (Appendix 1) which was to be administered by post to Heads of science and technical departments in one hundred colleges of further and higher education and polytechnics within England and Wales. The colleges and polytechnics were selected by a random method using the DES Regional Advisory Areas as sampling strata. After piloting the questionnaire in local colleges and making a few modifications, a final version of the questionnaire was distributed to the 278 departments which formed the main sample, during May and June, depending on when clearance letters had been received from college principals and polytechnic directors. The survey resulted in the return of 195 usable questionnaires – a response rate of just over 70 per cent. The questionnaires were coded and sent for a final computer analysis in late October.

A third aspect of the project's work, as mentioned earlier, was to assess what initiatives were being made on behalf of women by training, validating, professional and other science and technical organisations. To carry out this task most economically a standard letter was circulated to such organisations seeking information and views. A list of the organisations contacted in this way is given in Appendix 2. This circular resulted in a great deal of written information, policy statements and opinions relevant to the research topic and led, in a number of instances, to interviews with members of the organisations contacted.

After the results of the questionnaire and other researches had been analysed, nine departments were chosen as the focus for more detailed study. The departments were chosen as being representative of the major subject areas within science and technology and selected on the following criteria:

i. Presence of reasonable, or better-than-average numbers of women students.
ii. Presence of technician-level opportunities.
iii. Evidence that the department was actively encouraging women students in some way.
iv. Indications from the questionnaire responses that the Head of Department was interested in the research topic, irrespective of his/her views.

A fifth criterion 'presence of women staff' was dropped from the list although this factor was taken into account in other ways. Because time was limited for this phase of the research the case-study visits to departments had to be of short duration. Most visits involved a wide-ranging interview with the Head of Department and more specific discussions with course tutors and discussions with as many of the women students as were present in college at the time. This last series of discussions was held while students were engaged in practical work where possible as such occasions provided an informal atmosphere. In some, but not all cases, a short discussion was also held with the principal or vice-principal who could provide an over-view on such matters as the local employment situation, careers guidance and school or industry links which the college had set up. It was not possible because of the limited time available, however, either to conduct any curriculum observations or to hold equivalent numbers of discussions with male students so as to have a comparison with the women's experiences. It is realised that such data would have enhanced the research.

1.3 Why More Women Scientists and Engineers?

An underlying assumption has been made while describing the project and its aims that there are too few women in the scientific and technological fields and that greater efforts should be made to encourage more women to enter these professions. These, like all assumptions, are open to question and it is perhaps appropriate to discuss here the rationale behind such theses.

On the subject of the low numbers of women actually following non-traditional careers in science and technology, there is little dispute. One of the more commonly reported findings of the Finniston Committee's enquiry into the engineering profession (HMSO, 1980) was that 'less than half of one per cent of the current stock of engineers are women'. Of those currently undergoing engineering training, approximately three per cent of the total are women but, as Finniston points out, this increase has to be set against the facts that girls account for most of the increase in sixth-form numbers which has occurred over recent years and that a significant percentage of all science graduates are now women. The encouraging percentage of female science graduates (DES statistics for 1977 place the overall figure at 31 per cent) is deceptive, however, as the statistic is mostly the result of the relatively high numbers of women who have been studying the more traditionally-female subjects within the biological and medical sciences, not physics and chemistry. When the statistics for Further Education for 1977, shown in Table 1.1, are compared with the figures quoted for the top end of the education scale it can be seen that the situation is less promising in terms of participation by women students. Particularly poor results, with regard to female enrolments, are present for the electrical, mechanical and automobile engineering disciplines and building which are the most populous subject areas when overall student numbers are considered. It can be concluded, therefore, that women continue to remain in a minority within almost all scientific and technical fields and on current evidence (DES, 1980(a); MSC*, 1979) are likely to remain so for many years unless some marked change is effected within the system. As particularly low numbers of women students still exist within the technical and craft scholastic levels, these areas have been a special focus of attention for the report.

One of the strongest arguments for introducing special measures to increase the participation by women within science and technology is that up until the present the potential of half the nation in these fields has not been explored. The Finniston report highlighted the need to improve the pool of expertise in the engineering field because many of the more able students, boys as well as girls, were

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* Conference: 'Sex Differentiation and Schooling' held at Churchill College, Cambridge University from January 2nd to 5th, 1980.

** ERIC: Educational Research Information Centre.

* Manpower Services Commission.

Table 1.1 Proportions of Women Enrolling in Engineering and Science Courses within Further Education during 1977

Subject Area	Total Number of Enrolments	Number of Enrolments by Women	Women's Enrolments as a Percentage of the Total
ENGINEERING AND TECHNOLOGY			
a. Advanced	63,765	1,527	2·3
b. Non-Advanced	357,844	7,982	2·2
c. All Modes	421,609	9,509	2·3
Electrical Engineering	80,281	671	0·8
Building	73,687	652	0·9
Mechanical Engineering	63,927	318	0·5
Automobile Engineering	44,638	157	0·4
SCIENCE			
a. Advanced	27,754	7,139	25·7
b. Non-Advanced	12,476	4,614	37·0
c. All Modes	40,230	11,753	29·2
Chemistry and Applied Chemistry	7,941	1,202	15·1
Biology and Applied Biology	5,565	2,068	37·2
Physics and Applied Physics	2,160	134	6·2

Figures from DES 'Statistics of Education' for 1977, England and Wales.
Figures for named subjects within Engineering and Science refer to 'All Modes'.

and still are being steered away from these 'cloth cap' disciplines to more glamorous professions. 'It is alleged in particular', states Finniston, 'that the distribution of academic talent among entrants to engineering degree courses is excessively weighted to the lower end of the ability scale'. In other words engineering has been one of the 'easiest' degree subjects into which students have been able to gain entry. While this may also be true for some full-time physical science and technology courses within Further Education, it is likely to be less of a factor amongst block- and day-release students at the present time. Employers are able to pick and choose whom they employ and, because of the current financial climate, are inclined to allow only the best of these to attend college for further education and training.

A second argument for increased numbers of women scientists and technical staff arises from the fact that there is still a shortage of qualified employees in some technical areas although, as the Finniston report says 'the available evidence regarding employers' demands for engineers is piecemeal and anecdotal and it is difficult to formulate any overall picture of the demand/supply situation from it'. Despite this the report went on to suggest some prime areas of need, such as for qualified, professional personnel of almost every discipline, but particularly for the manufacturing industry, electronic and software engineers and technician engineers 'for engineering support and first-line supervisory posts'. The last of these specified areas, i.e. technician engineers, was emphasised as being one of 'acute' need. During the course of this study other job vacancies were mentioned to the project team such as that of chemical process operator, instrument technician, engineering designer, shore-based radio engineer and operator and computer programmer and analyst. On the scientific side the most obvious lack of man/woman power occurs in the teaching profession. There is a marked need for more physical science, craft, design and technology teachers both in the schools and in some cases within Further Education. The shortfall in secondary school science staff has been highlighted by a recent discussion paper by Her Majesty's Inspectorate on postgraduate certificate of education courses, which has shown that less than one third of students on these courses are scientists (DES, 1980(d)).

A further factor relating to women entering science and technology concerns women's employment prospects. While the activity rate of women has gradually increased over the years until it has reached a point where women are now occupying approximately 40 per cent of the labour force in the United Kingdom, job opportunities in traditionally-women's occupations are drying up at a faster rate than in other sectors. This is said to be particularly serious for young women who have few qualifications and have recently left school. The spheres in which job opportunities are receding at the fastest rate are in the clothing, footwear and textile industries (MSC, 1979). Part-time workers, the greater proportion of whom are married women, have always been the least secure employees in times of financial hardship. Part-time lecturing posts within Further Education, for instance, are under considerable pressure at the moment. In the coming years the introduction into offices and other administrative centres of 'the new technology' in the form of word processors, computerised data banks and filing systems will inevitably lead to a decline in the need for clerical and secretarial staffs. Offshoots of this same technology will reduce the numbers of shop-floor operators and assembly workers, many of whom are currently women. It might be reasonably expected that the push-pull influence of jobs receding in some sectors and opening up in others would be sufficient to encourage women to move out into a wider range of job situations where good opportunities still exist, but as yet there is little evidence to suggest that this is taking place to any extent. Perhaps this indicates that there is a need for some measures to be taken in order to encourage such a trend.

Lastly in consideration of why there should be more encouragement for women to become scientists and technologists is the ethical argument: women have a right to fulfil as equal a role in all aspects of working life as men. Since the Equal Pay and Sex Discrimination Acts in 1973 and 1975 respectively, some would argue that equal opportunities for women and men do exist and there is no need to take any further action. The fact that since these dates women have not been rushing to take up opportunities in non-traditional areas implies that equality of opportunity is not the sole governing variable. The major factors affecting women's take-up will be discussed in Chapter 2 and again in Chapter 4. Many women, it must be recognised, may not want to have a demanding career which conflicts with the domestic role which they are quite happy to fulfil and there is indeed a danger that some unjust pressures might be brought to bear on such individuals in a climate of 'equal opportunities'. But what of the others who would like to enjoy more interesting and better-paid employment prospects?

A case which reached the law courts during 1979 presented a new insight into the question of equal opportunities. The case concerned the right of a girl, Helen Whitfield, to have the opportunity to take craft lessons at a London school which up until that point had never afforded girls such an opening. Initially the school refused to allow the girl to take the craft studies she desired, with the result that, supported by the Equal Opportunities Commission (EOC), a case was brought under the Sex Discrimination Act. Before the case could be taken to court the school reversed its previous ruling and gave the girl permission to join a craft class full of boys. However, the action was not dropped at this point but was continued (without EOC support) on the grounds that the girl was still being discriminated against because she would have to study in a disadvantageous environment to which she was not accustomed. Although the case was backed by several equal opportunities campaigners who considered that access to an opportunity was not the same as having equal access, the judge ruled that there had been no discrimination. Many young women taking technology and engineering courses within Further Education are faced by the prospect of being the only woman in an all-male classroom with, almost certainly, a male teacher. Discussions with young women who had experienced this situation indicated that, excepting the most forceful personalities, most did feel a certain sense of isolation and spoke of having to 'put up with' ribbing from the men and of the need to make an effort 'to fit in'. It was equally true, however, that after a few weeks the women felt that these problems had more or less disappeared or had been coped with and the main difficulties which lay ahead were of an academic nature.

The question of women being indirectly discriminated against simply because they are in a domain dominated by the other sex leads on to the controversial question of providing 'positive discrimination' for women in such situations. Perhaps with the aforementioned problems in mind, provision was made under Clause 47 of the Sex Discrimination Act for the single-sex training of women (and men) in order to prepare them for jobs which traditionally have been occupied by the other sex. Certain designated training bodies such as the Manpower Services Commission (MSC) and the Industrial Training Boards (ITBs) automatically have the right under the Act to run such courses while other education and training establishments such as colleges can apply for special designation in order to do so. The Training Services Division of the MSC has implemented this right by sponsoring a number of 'Wider Opportunities for Women' courses aimed at women who would like to return to work after a break but who need help with job-related information, confidence building and decision-making. Of the Industrial Training Boards the Engineering ITB has been the most active in terms of making special curricular provision for women and allocating to them special training allowances. Colleges and other educational establishments in Britain, however, have been slow to follow such leads and only one known course (entitled 'New Opportunities for Women' at Hatfield Polytechnic) has received special designation in order to restrict the enrolments to women. It should be stated that there is nothing to stop colleges running courses which are principally aimed at the needs of women or which include the word 'women' in their title, as long as men are allowed to attend if they so wish.

What are the advantages and disadvantages of making special educational/vocational provision for women? One advantage of women-only classes is that women have the chance to learn new skills, gain confidence and prepare for an entirely new career in an atmosphere which is said to be less threatening for them than in a 'mixed' situation. Past surveys of secondary schools (DES, 1975; DES, 1979) have shown that girls and boys study, and are examined in, a differing mix of subjects, with girls tending to have a deficit on the science and technology side. Single-sex classes would allow the curriculum to be geared to the task of overcoming educational deficiencies suffered specifically by women. It is noteworthy that the secondary school surveys conducted by HMI have shown that girls in single-sex schools are likely to be studying more science than in mixed schools while another survey (Page and Nash, 1980) has determined that their attitudes to technology-based subjects are more favourable in single-sex schools than in mixed establishments, while the reverse is true for boys.

It is recognised that the provision of courses geared to the needs of any special group within Further Education would be difficult to achieve in the present economic climate when both financial and staff resources are short. The questionnaire survey conducted by the project (v. Chapter 4) showed quite conclusively that science and technical departments are not involved with making separate and special provision for women, even if their staff are convinced of the need. In some cases there was considerable hostility to any idea that such positive discrimination should be made, even for a limited period, on the somewhat questionable grounds that (a) it would be unfair to male students who are in the majority and (b) it is not necessary. A review of special provision made for women in the United States, Canada and Scandinavia (Stoney and Reid, 1980) indicated that college staffs in these countries were generally more receptive than in Britain to the idea of running especially-designed educational and training programmes for women although their differing traditions to our own may account for this variation in attitude. In terms of exploring ways which might help and encourage more women to enter and to progress within science and technology in Britain, therefore, it is perhaps more acceptable to speak of making 'modifications' to current curricular and teaching approaches and departmental organisation, where necessary, rather than of making radical changes. While the report has attempted to do this it is recognised, as mentioned by one of the Heads of Department in the questionnaire survey, that 'there is no magic cure'; the problem will require 'a persistent and relentless approach', not only within Further Education but in the schools and work places.

CHAPTER 2

Perspectives

Many measurements have been made over the years which suggest that, on average, females and males* display differing abilities and behave in differing ways under a variety of circumstances (v. Maccoby and Jacklin, 1975). Whether these differences are innate or learned or the result of a combination of factors remains as much in dispute today as the actual size of the measured difference itself. The emphasis of this chapter is on a discussion of the influence of alleged sex differences, sex stereotyping and related issues on the problems of (a) the entry and participation of women within science and technology and (b) their subsequent progress and attainment relative to men.

2.1 Sex Differences in Attainment

Variations in the attainment of girls and boys are, because of the formalised way in which public examinations are organised and monitored, some of the most well-documented sex differences. In Table 2.1 a comparison is made of their relative entry rates and performances in GCE 'O' level examinations for 1976 (Murphy, 1978). Ordinary level examination results are cited because these are the qualifications most likely to be required of school leavers for entry into a wide range of Further Education courses. The statistics in Table 2.1 clearly show that, with the exception of Biology, girls had a higher entry and pass rate in subjects which have been traditionally stereotyped as being 'female' and boys similarly in those usually stereotyped as being 'male'. It should be noted, however, that the sex difference in subjects most frequently studied by girls is much greater than that for Physics, Chemistry and Mathematics. The reason given by Murphy for this result is that girls have a greater all-round level of attainment than boys at the 'O' level stage when most students are around the age of sixteen years.

A further implication of the results shown in Table 2.1 is that the educational backgrounds of young women and men entering Further Education are different, a factor which determines to a great extent their differing subject choice in post-school education and ultimately careers. While in overall terms girls appear to leave school having studied proportionally less science, or at least less physical science, than boys (v. DES, 1975 and DES, 1979) and enrol in far fewer

Table 2.1 Comparison of Male and Female Entries and Pass Rates in Various GCE 'O' Level Examinations in June 1976 (all boards).

Subject	Sex	Entry	Percentage Obtaining A, B, C Grades	Comments
English Literature	Females	141,000	64	Higher female entry and pass rate
	Males	106,000	54	
English Language	Females	203,000	65	Higher female entry and pass rate
	Males	183,000	56	
French	Females	84,000	64	Higher female entry and pass rate
	Males	66,000	58	
Chemistry	Females	30,000	60	Higher male entry and pass rate
	Males	60,000	61	
Physics	Females	25,000	58	Higher male entry and pass rate
	Males	86,000	59	
Mathematics	Females	87,000	56	Higher male entry and pass rate
	Males	116,000	60	
Biology	Females	86,000	56	Higher female entry
	Males	61,000	61	Higher male pass rate

After Murphy, R. J. L. (1978).

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* The terms 'girls/boys' are used in this report to refer to the school situation, and the terms 'women/men' to the college/polytechnic/university environment.

numbers than boys on scientific and technical courses (Table 1.1), it is difficult to determine whether those who choose science and technology in Further Education are actually educationally disadvantaged relative to boys on a course for course basis. There are at least two contrary factors at work and probably others. On the one hand the girls may not have received the same amount of previous science and craft teaching as boys while at school, because of the 'hidden curriculum' of schools and school attitudes, and may not have had the same opportunity to develop the practical skills which form an integral part of any technology course. On the other hand, because science and technology still remains a non-traditional domain for women, only the more able and the more motivated girls or those, who for some special reason, have benefited from having a good opportunity to become acquainted with these subjects, choose to enter such fields. The indications from the present study are that both factors are at work to a certain degree, thus producing a complicated pattern of female take-up and achievement in the science and technology areas.

If girls perform less well in public science examinations, is the same true in Further Education for those studying science and technology? Unfortunately official statistics are not collected in a manner which would allow this to be determined. The fact that women taking science and technology are to some extent a self-selected group would preclude the measurement of any sex difference in women's overall ability with accuracy. An indication can be found, however, of the way in which the performance of girls and boys in science varies in a number of countries over the teenage years. The data shown in Table 2.2 were collected by the 1970 survey of the International Association for the Evaluation of Educational Achievement (IEA) as reported by Keeves (1973). The students in the sample were tested on their science ability and knowledge irrespective of whether they were studying science subjects at the time. The table indicates that the sex difference is neither constant between countries nor between the ages of 14 and 17-18 years. In all instances where data were collected the sex difference increased between the two levels, suggesting that either boys 'naturally' leap ahead in these skills as adolescence progresses or, more probably, that the opportunity and encouragement for girls to study and excel in science in their late teens diminishes relative to those for boys, with the more able girls being steered away towards a curriculum dominated by arts subjects.

Evidence that sex differences in science performance are affected to a considerable extent, if not solely, by cultural or social influences existing in a particular society at any one time is shown by other data collected by the IEA survey of 1970 and reported by Kelly (1978). In Figure 2.1 the mean achievement scores of girls and boys are shown for 14 countries and reveal that in some countries (notably Japan and Hungary) girls' scores in science are above those of the boys in others. Such variation in the results between countries indicates that at the very least, influences other than innate biological differences are at work. This is further substantiated by research reports given recently by Fennema (1980) and Jacklin (1980) at the Cambridge conference on sex differentiation and schooling. Both researchers stated that their measurements of sex

Table 2.2 Sex Differences in Science Scores*

Country	14-Year Old Level	Pre-University Level
Australia	50	78
Belgium	39	46
England	23	89
F. R. Germany	62	76
Finland	59	104
Japan	74	—
Netherlands	65	100
Scotland	53	115
Sweden	47	93
United States	48	60
Average Standard Deviation for All Countries	11·0	9·5
Number of Items Tested	80	66

* The figures in the table refer to the difference between the mean test scores for girls and boys divided by the average standard deviation for all countries and the result multiplied by 100.

Data from IEA Study, 1970 as reported by Keeves (1973).

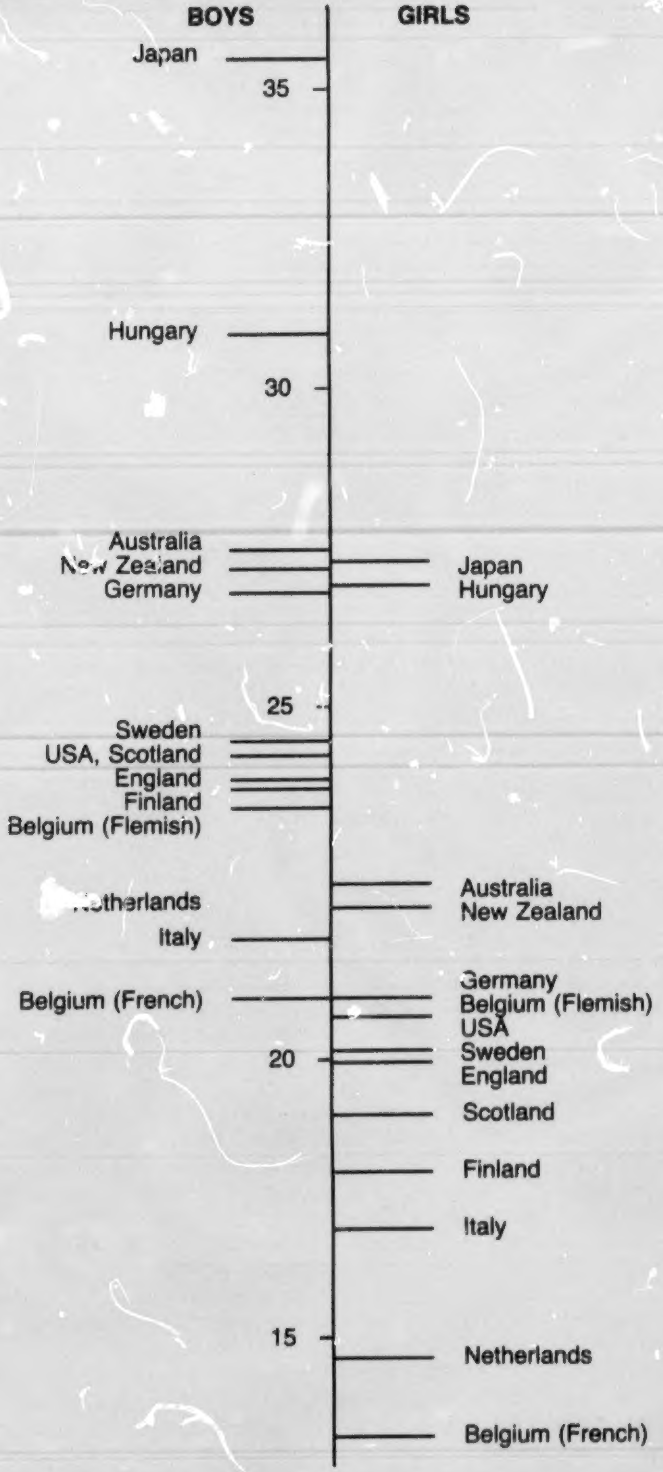

Figure 2.1 Mean Science Scores* of Boys and Girls in Fourteen Countries (after Kelly, 1978).

* Figures same as in Table 2.2.

differences, both innate and otherwise, had varied in magnitude over the space of time in which they had been engaged in this type of research. Certainly, societal attitudes can be expected to have changed somewhat over the last ten years since the IEA survey was conducted. It would be interesting to discover whether their survey results would be replicated in 1980. In addition to sex differences in performance varying between cultures and over time they have been found to differ within a much smaller arena. Fennema and Sherman (1977) analysed sex differences in mathematics and visuo-spatial achievement of children within several schools in an American city and came to the following conclusion:

'The very fact of variation from school to school in the occurrence of sex-related differences on cognitive factors makes it less likely that the differences observed can be attributed to sex per se. While it has sometimes been supposed that failure to replicate sex-related differences in other cultures eg. Eskimo, could be attributed to the existence of a somewhat different gene pool, it appears erroneous to assume that there are different gene pools within the white population of one mid-western city.'

Much of this section has comprised a discussion of sex differences in attainment as revealed by school-based research here and abroad. It is a pity, especially from the point of view of providing data for this study, that scarcely anyone has taken up the challenge within the Further and Higher Education sectors, even though the design problems for such studies would be considerable. As mentioned earlier, the students in these sectors are to some extent self-selected and this factor may itself vary by gender. The DES monitors the numbers of females and males enrolling and receiving degrees each year but does not relate exam attainment to enrolments for the appropriate year groups so that the relative success rates can be measured. Further Education statistics provide only enrolment data without exam-performance figures. If such data were available and sex differences in performance found to exist amongst science and technology students, then this in itself might be considered to be a basis for making special provision for those suffering some disadvantage.

2.2 Innate Sex Differences

Towards the close of the last section mention was made of the possible relationship between performance and innate, cognitive variables. In this section a deeper examination is carried out of biologically-determined factors which might influence women's and men's overall performance in science-based disciplines. Previous research has indicated that there are several such ability factors which might be expected to have some bearing on scientific ability and learning. These are:

i. Verbal ability, i.e. the ability to comprehend and to execute the written and spoken word.
ii. Visuo-spatial ability, i.e. the ability to rotate an object mentally in two- or three-dimensional space.
iii. Mathematical ability.
iv. Manipulative ability.
v. General ability or intelligence.

Over the years many measurements have been made, especially in America, of the sex differences in the verbal, visuo-spatial and mathematical abilities displayed by school-age children. The results of these testing programmes have tended with one or two exceptions[*] to suggest that, while girls have on average a higher verbal ability than boys and a higher rate of increase in this ability over the teenage years, the converse is true for boys and visuo-spatial and mathematical ability (Maccoby and Jacklin, 1975). The sex difference in visuo-spatial ability is said to be greater than that for verbal ability although in almost all cognitive-test results the differences within each sex have been found to be of a much greater scale than those between sexes.

It may not be sufficient to consider each cognitive variable by itself in relation to students' learning patterns. All three variables mentioned above, for instance, are likely to be dependent on general intelligence level. Science is recognised to be a difficult subject conceptually so that the 'intelligence' factor may act as a screening agent in selecting only those people who particularly wish to or are able to assimilate science-based curricula. It has been suggested that school science syllabuses may be unduly difficult with regard to the cognitive development of teenagers and HMI has noted (DES, 1980(c)) that 'girls are particularly affected by the premature introduction of abstract concepts and excessively mathematical approaches based on too little practical experience'. There may be something to be gained, therefore, from leaving some aspects of science curricula until later (i.e. in Further Education) when students have gained a better all-round maturity.

The close inter-relationship of cognitive factors has been highlighted by Fennema and Sherman (1977) in their study of American teenagers. They reported that verbal, mathematical and visuo-spatial abilities all significantly co-varied with each other amongst their samples of girls and boys. Interestingly, they found that by co-varying out the difference between the sexes in the number of mathematics classes taken, the sex-differences in spatial visualisation tended to disappear as did the sex-difference in mathematical achievement itself. After reviewing this and related researches, Jacklin (1979) concluded that visuo-spatial ability is a 'bi-product of mathematics learning – particularly of "higher" mathematics classes' where spatial concepts are taught. If young women have the opportunity to study sufficient mathematics, she speculated, any deficit which they currently exhibit in this skill will tend to disappear.

Verbal reasoning is a skill which is often over-looked in relation to success in science but it is in reality very relevant. A significant part of science curricula is taught through lecturing and demonstrations and students are required to write up experiments and produce reports. As written test results continue to suggest that girls have a superiority in these skills and are, at present, at some disadvantage in science classes, it has been suggested (Fennema, 1980; Kelly, 1981) that teaching staff should pay more attention to the utilisation of these skills in relation to science learning. However, there may be a danger in this, in that by providing the opportunity for girls and women to accomplish a task within their capabilities and to utilise only known skills, progress in other skills may be restricted and they may never gain the necessary practical expertise to succeed easily in an industrial environment, should they choose such a career pathway.

Sex differences in manipulative ability have not been the subject of the same degree of experimentation as other skills and this factor tends to be mentioned only in passing when science learning is discussed. There does appear to be a consensus of opinion that manipulative skills can be taught irrespective of background and sex, although those who have been able to practise such skills at home or through hobbies are likely to have an initial advantage on starting a course which includes these techniques. It might be postulated, however, that, despite the fact that there has been little exploration of sex differences in manual dexterity, women have an edge over men in some practical tasks since they are commonly engaged on assembly work within the electrical and electronics industries where delicate manipulations have to be made.

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[*] A study by the Education Commission of the States in 1978 on 3,000 American teenagers found that visuo-spatial ability in 13-year-olds was better developed in girls than boys and that at 12th grade the sexes were comparable in ability.

The resulting picture from cognitive sex-difference testing is both complicated and in a state of change. The magnitude of sex difference measurements has been found to differ considerably between cognitive factors, between cultures (v. Johnson, 1974 on verbal ability), between researchers (v. Stanley and Benbow, 1980 and Fennema, 1980) and over time (v. Jacklin, 1979 and Fennema, 1980). The overall trends in results, especially with regard to visuo-spatial and mathematical ability, however, suggest that sex differences in cognitive functions are much smaller than earlier studies revealed, attributable to more than one cause and may not have a physiological basis. With regard to the biological research, it has for a number of years been speculated that the male and female brains function differently, with opposite sides of the brain being better or differently developed in each sex, i.e. the brains have been said to be 'lateralised'. The left and right hemispheres of the brain have been thought to govern different cognitive functions. However, recent research now suggests (Gooch, 1980) that each side of the brain separately can control all functions if necessary in either sex. Another biological factor, a sex-linked recessive gene, has been supposed to be related to similar visuo-spatial ability in parents and children but this hypothesis is now thought to be untenable in the light of recent research (Kelly, 1978; Jacklin, 1979).

The fact that such wide variations occur in the magnitude of measured sex differences gives further credence to the argument that biological differences are not as important as was previously suspected while socialising factors (which are susceptible to variation according to the political-social-economic climate existing within any society) are probably much more important. Cognitive ability tests, after all, measure both learned as well as innate skills without regard to which is the more dominant. After reviewing many studies which examined allegedly 'innate' variables Jacklin (1979) commented, 'we do not know the causes of cognitive sex-related differences and since their probable causes in the social milieu are changing, we must keep our eye on what requires explanation'. She concluded that the emphasis in previous research had been heavily biological; there was a need to 'trace out the socialisation effects' and to develop 'more complex interaction models which relate biology and environment'. One such idea that calls for closer examination, for instance, suggests that small or insignificant innate sex differences may be magnified out of all proportion by socio-economic variables. If innate, sex-related factors are, however, insignificant then the major implication for the present research is that there are no insuperable barriers to women succeeding in science and technology on comparable terms with men. Moreover, the problems which are currently inhibiting women from pursuing careers in the scientific and technical spheres in greater numbers, should be open to solution by suitable remedial strategies, even if these require a long-term commitment.

2.3 Attitudes

A multiplicity of factors influence women's attitudes to science and technology – society's overall attitudes, teachers'/lecturers' attitudes, peer group, and parental and employers' attitudes. In educational and vocational terms it would also appear that the presentation and design of curricula have a strong effect on students' attitudes. Curriculum-related issues and their influence on attitudes will be discussed in Section 2.5. In this section a small insight is given into more general aspects of the greater attitudinal problems which relate to women and their motivations towards science and technology.

2.3.1 Teenage attitudes to science

Researchers have investigated the difference in attitudes to science of school-age children (v. reviews in Ormerod with Duckworth, 1975; Kelly, 1978) using different attitudinal measurement scales, and found that in general girls have significantly poorer attitudes to science than boys. These findings have been corroborated in the last few months by a study of teenage attitudes to industry and technological subjects taught in schools (Page and Nash, 1980). The authors conclude that favourable attitudes to technology, and the subsequent take-up of higher level courses by young people, are dependent on the opportunity to study technological-based subjects, a finding which has particular implications for girls who sometimes lose out on this opportunity relative to boys. In addition the survey results indicate that girls in single-sex schools, and to a lesser extent boys in mixed schools, tend to have more favourable attitudes to technology, but as the authors comment, these indications 'offer no simple formula upon which educational administrators might act'. Presumably they are referring in part to the difficulty of providing single-sex classes in a time of financial restraint and when the overlying trend is towards co-education.

One or two researchers have found, however, that it is possible to change girls' attitudes to science and technology and to increase their scientific skills without having to make drastic changes. In an often-quoted study, Torrance (1963) found, for instance, that by exposing young girls to scientific toys over a period of a year, the girls' reluctant attitudes to the toys and their skill deficiency relative to the boys were significantly improved. More recently Fennema and her colleagues at Wisconsin-Madison University (Fennema, 1980) have developed a successful programme of 'intervention strategies' entitled 'Multiplying the Options, Subtracting the Bias' aimed at changing adolescent girls' attitudes to, and their take-up of, mathematics classes. The programme consists of a series of video-tape films, organised discussions and discussion material which were prepared for three interested parties – the girls, their male peers and the teachers. The films described the problem, showed the differing behaviour of girls and boys in typical mathematics classes, reproduced interviews with the students and stressed the career importance for girls of taking mathematics in school and college. It would seem, therefore, from this and related studies that one avenue into the problem may be through discussion, by simply alerting the different parties involved to the problems and consequences of girls and young women studying or not studying science- and technology-based subjects. The other obvious approach suggested by these researches is to ensure that equal opportunities and facilities exist in practice for both sexes to study and have contact with science and technology at all levels.

Young people's attitudes and motivations to science and technology can be measured not only on a 'less favourable-more favourable basis' but also by exploring their perceptions of scientists and technologists as people and science and technology as disciplines or careers. Ahlgren and Walberg (1973) studied the attitudes to physics and physicists of those taking physics in American high schools. They assessed students' perceptions of a variety of occupations including that of 'physicist' and found that students tended to perceive the occupation of physicist to be of great 'importance', to require a high degree of 'maturity' but to rate very low on 'friendliness' (the three variables are composite factors attained by measuring attitudes on 15 semantic differential scales and then conducting a factor analysis). This result compares with that of several other studies which have shown that scientists are often perceived to have insular, independent and intellectual personality traits which are essentially 'male' in character. In contrast to the result for the physicist, however, Ahlgren and Walberg found that the occupation of 'doctor' was perceived to rate highly on all three factors, whilst that of 'plumber' to rate lowly, i.e. a plumber was not thought to be an important person who needed great ability and neither was he/she seen to be particularly approachable. The researchers then progressed to correlate different aspects of the physics discipline with 'student interest' and recorded a sex difference in the result. Girls were found to correlate interest more highly than boys with the adjectives 'humanitarian', 'social' and 'artistic' but to correlate it much lower than the boys with the adjectives 'practical' and 'applied'. The importance of the social implications of science-based disciplines to girls and women has been noted by a number of other authors and is just one of the several ways in which women's attitudes have been found to differ in type as well as magnitude to science and technology from those of men.

2.3.2 Role-model influences

As mentioned previously, the vast majority of research on sex differences has concentrated on the secondary school environment; disappointingly little has been carried out in colleges and universities. One 'attitudinal' area which has been the subject of college-based studies is that of role-models. O'Leary (1974) describes a 'role model' in the following terms:

'The essential quality of the role model is that he or she possesses skills and displays techniques which the actor (in this context the women student) lacks or thinks she lacks and from which, by observation and comparison with her own performance, the actor can learn . . .'. '. . . the model merely provides a technical explanation of how the role is to be performed.'

One study in particular has examined the attitudes and motivations of American college and university students (Phelan, 1979). Phelan initially identified three potential sources which might have an influence on student motivations; staff (faculty), task involvement and peers. The research revealed that contact with senior staff members and a high degree of involvement in academic work had the greatest positive impact on student motivations and that contacts with staff members had a greater impact on women's motivations than 'academic involvement', while the converse was true for males. The explanation given for this result was that, whereas men anticipate eventual placement in scientific or scholarly roles, women, who have been confronted by societal pressures may need to be personally reassured that they can be a scientist or scholar. Phelan went on to speculate that 'contact with professors (lecturers) may operate on two different planes: for men it is pragmatic and instrumental; for women it is idealistic, i.e. goal setting and expansive'. Other studies into role-model influences (Almquist and Angrist, 1971; Tangri, 1972) have produced similar findings and shown that for women for whom careers are salient, college staff and persons in the occupation are the most important motivating influence whereas for those who do not rate careers so highly there was either no-one who had particularly influenced their course choice or they named a member of the family. In terms of girls/women who wished to pursue non-traditional career pathways, Jacklin (1979) speculated that the role-model influence has been largely underestimated. O'Leary (1974) in her review of work in this field considered that 'the absence of female role models functioning successfully in male-dominated fields may act as a considerable barrier to the occupational aspirations and achievement-directed behaviour of women in the work force' and she emphasised that 'to defy societal role expectations requires a strong personality'.

The implications for the present research from these previous findings are considerable. They suggest that staff in Further Education do have a crucial role to play both in terms of encouraging the progress of women students by personal contact and example and of encouraging their entry into science and technical departments by making contact with those who have the necessary potential while at school or before enrolment. Women staff members, where they exist, should be particularly encouraged to make contact with school-age girls and to be available when students are enrolling for courses.

2.3.3 Personality factors and the socialising process

One aspect of attitudinal problems, which seems to have been overlooked by many authors, is that poor attitudes are (partly or wholly) the result of lack of information or mis-information. As a consequence people are either inhibited from following a certain course of action (i.e. women from entering science and technology) or are forced, because of their inadequate knowledge, to be dependent on other people's attitudes and judgements. Women are to some degree dependent on society's attitudes to science, technology and industry for which the stereotype appears to be one of a male domain in which women are cast as outsiders. Research by Dweck et al (1978) has given some weight to this argument as their findings indicate that girls are much more dependent on external opinion and measures of their abilities than boys, who tend to be more self reliant and are less easily put off by the occasional failure or disconcerting educational experience.

Other 'internal factors' tend to place women at a disadvantage relative to men in vocational terms according to O'Leary. These are:

i. Fear of failure.
ii. Low self-esteem.
iii. Role conflict.
iv. Fear of success.

However, 'internal' though these factors may appear to be in some senses it is likely that they are rooted in the socialisation process. As Walters (1974) comments, 'it seems difficult to consider self-image without taking "external circumstances and social pressures" into account when, in the main, theories of "self" are closely linked with perceptions of "others"'. The above-mentioned personality traits shown by women have been found to have external expression in a number of ways. They tend to restrict the range of tasks, situations and occupations which people are likely to choose for themselves, thus encouraging women to preserve the vocational status quo and not to venture into new territory. Secondly these influences may lead women to set their career aspirations below those of men and to achieve less well because they do not expect to be able to compete on equal terms. Thirdly they may lead to a lack of confidence and anxiety in women who venture into 'non-traditional' environments such as mathematics and science classes, laboratories or workshops and this may show itself in an 'apparent' lack of talent or skills. Several research programmes have investigated the problem of the anxiety experienced by women when faced with mathematics and science classes and in America these have resulted in the setting up of 'maths anxiety' clinics in a number of American schools and colleges (Tobias, 1978) where students can sort out their problems as they occur, and in one British case (Davies, 1980), a series of teaching strategies which help allay women's fears. For those women who do succeed in challenging or non-traditional career roles they may encounter the practical problems and conflicts of conscience occasioned by an attempt to fulfil both their commitments to a career and to a home. It has been claimed (Turner, 1964) that women do not forfeit their domestic responsibilities for a career but simply take on an additional role, whereas men tend to be single-minded in whatever they perceive their main task to be at any time.

As a conclusion to this section which has attempted to make a cautious entry into the minefield of issues associated with attitudes, a quotation is presented from the excellent review of O'Leary (1974), which seems to sum up some of the problems of women in science and technology:

'The woman who seeks employment in a traditionally masculine position is faced with a dilemma. Society views the ideal woman as an expressive individual lacking in the masculine attributes of logic and drive. If she feels that because she is not a man she is not endowed with the competency characteristics ascribed to men, she may suffer from lack of confidence concerning her ability to do the job well. If, on the other hand, she feels that she has the potential to manifest masculine traits, she may feel that allowing such characteristics to surface might be detrimental to her femininity, rendering her "less of a woman".'

It is this dilemma which educationalists should, perhaps, be more actively engaged in helping girls and women to resolve.

2.4 The Classroom Situation

2.4.1 Student participation

While girls may possess on average a better written verbal ability than boys, some research (Good et al, 1973; Spender, 1980) has shown that in terms of classroom participation, boys tend to use verbal skills to greater effect and maintain a dominance in mixed group discussions. This finding has also been described in terms of the amount and type of teacher interaction with school-age children. Good et al, for instance, found that teachers tended to react generally more frequently with boys and with high-achieving boys in particular. Good and Dweck (1977) concluded that boys tended to receive a higher proportion of criticism from teachers than girls and Dweck that this was more often than not related to non-academic behaviour whereas for girls any feed-back tended to be directed more towards their work. As the Spender (1980) research, conducted in Britain and that by Townsend (1972) in America both revealed that adult women tend to play a more passive and less communicative role in college classrooms than men, it would appear that sex differences in classroom behaviour patterns have a certain currency for all ages. By maintaining this verbal dominance, Spender argues, boys or men make the classroom a male domain in which girls or women are to a lesser or greater extent afraid or unwilling to participate. If this supposition can be further substantiated, there are important implications for teaching in general and especially for scientific or technical situations in which girls and women are in a minority. One of the recommendations made by Her Majesty's Inspectorate as a result of their recent survey (DES, 1980(c)) was that science teachers 'should consider involving girls more actively in question and answer sessions' and this is also probably true for Further Education.

Does lack of participation and questioning by female students place them at a learning disadvantage or do they try to compensate for this in some way? Interestingly, Serbin and her colleagues (Serbin, 1980), in an experimental study into classroom behaviour deduced that school-girls' behaviour tended to be closely associated with the teacher's movements; they liked to remain close to the teacher whilst boys were quite happy to remain at a distance, involved in some activity peripheral to the main teaching. Perhaps the girls were unconsciously seeking the attention which intuitively they did not feel themselves to be receiving. Again these results have been reproduced for women college students (Townsend, 1972). An interesting question arising from the observations that sex differences occur in classroom behaviour over a wide age range is whether the results are created more by the students than by the teachers. It has been widely mentioned in the literature that teachers/lecturers have a major influence on students' attitudes, subject and career choices. However, the study of Good et al (1973) suggested that sex differences in classroom interaction patterns are mostly due to the students, not the teacher. In the words of the authors, 'teachers are primarily reactive to the differential presses that boys and girls present'. Moreover, the research found that female and male teachers reacted similarly to girls and boys, i.e. that although there were sex differences in teacher behaviour, this was unrelated to the sex of the student.

There is obviously a clear need for further research into classroom behaviour patterns and their relationship with students' progress and attainment, particularly in the post-sixteen age group. In order to produce worthwhile results in this complex area it might be envisaged that such research would require observations to be recorded over a considerable space of time, in a variety of learning situations and with relatively large populations.

2.4.2 Learning styles and teaching practices

A number of American studies, using attitudinal instruments with female and male college students (for example Brainard and Ommen, 1977; Townsend, 1972) have produced empirical evidence which suggests that women and men prefer to learn in somewhat different ways. Brainard and Ommen concluded that women prefer a more structured learning environment than men and possess a higher interest in instruction which is well organised and adequately detailed. It was also suggested that they prefer the 'listening mode' while men tend to opt for learning by 'direct experience'. Townsend investigated female and male attitudes to the four following learning conditions:

i. Teacher-directed courses.
ii. Student-oriented courses.
iii. Group-counselling courses.
iv. Traditional courses.

It was revealed that contrary to the men, 'female students were in favour of the teacher-directed learning situations and against taking an active part in the class preparation or conduct'. It was also claimed that they displayed negative tendencies towards the group counselling situation. Townsend concluded that women students were more influenced by the method of instruction (i.e. the teaching) than by the content of instruction (i.e. the curriculum). These findings are consistent with those mentioned previously relating to role models and teacher interactions which reveal the importance to girls and women of interpersonal relationships and teacher contact.

The inference to be drawn from this attitudinal research is that girls and women may prefer the lecturing and demonstration approach to science-based teaching and may not be so at ease as boys and men in scientific classes where the emphasis is on practical work. One or two studies which have attempted to explore this hypothesis have concluded that there is some substance in such an argument. Babikian (1971), for instance, in an empirical investigation into the relative effectiveness of discovery, laboratory and expository methods of teaching science concepts to American teenagers detected that girls had a much poorer overall achievement than boys in the discovery-learning mode than in the other two situations tested, although 'High I.Q.' boys outstripped the girls in all three situations. A number of British researchers, meanwhile (v. Harding, 1973; Ormerod with Duckworth, 1975) have questioned the validity of using the Nuffield science teaching approach with girls. Her Majesty's Inspectorate (DES, 1980(c)) have also made several comments which are pertinent to science teaching and girls' attitudes and progress, stressing that, 'teaching styles play a large part in forming the views of pupils about different subjects'. They considered that:

i. 'Over-theoretical note-taking approaches are not liked.' This is true of boys as well as girls.
ii. 'Practical work is a major attraction of science. A more practical approach in years three, four and five, particularly in physics, would help to maintain the interest generated in early years.' In the case of girls this contradicts the findings reported earlier in this section.
iii. 'More care might be taken with the appearance of laboratories. A more stimulating appearance is often appreciated by girls.'
iv. As mentioned previously but presented here for completeness, 'science teachers should consider involving girls more actively in question and answer sessions . . .'.
v. In line with Kelly (1981), 'a firm line of discipline is needed so that girls do not become the focus of ridicule in mixed classes when they meet with problems'.
vi. Also supported by Kelly (1981), 'Staff ought to be more sensitive about the problems girls face in science and find methods of giving support and encouragement'.

Further teaching strategies cited by several authors refer to the fact that science classes have often been structured with boys and men in mind while not sufficient account is taken of skills in which females have a forté for whatever reason. For example, it has been suggested that the importance of good essay and report writing could be valued more together with their meticulous attention to detail and to the taking of measurements.

The studies described in Sections 2.4.1 and 2.4.2 provide more evidence that females and males have different learning needs and so give further weight to the argument that single-sex classes might provide part of the answer to the under achievement and under representation of women in science and technology. It is notable, however, that Her Majesty's Inspectorate was reluctant to call for such action in schools. While single-sex provision is not likely to be possible to any extent in Further Education at the moment, an increased flexibility of teaching approach is possible here relative to the schools, and staff might be able to tackle some aspects of the problem through, for instance, their tutorial systems. Additionally, it is not uncommon for science and technical departments to run remedial classes for students with mathematics or language difficulties, so that there are precedents for developments in this area if a sufficient need were felt to exist.

2.5 Scientific Curricula and Materials

Can scientific curricula and materials have an influence on women's take-up of science and technology courses and careers and affect their subsequent progress and attainment? There are indications that such factors can act as significant agents for change or for preserving the status quo in a number of ways. The work by Torrance (1963) is just one already-mentioned example of how the curriculum can be utilised to good effect. By exposing pre-adolescent girls to suitable scientific materials it was shown that both their responses to science and their scientific ability improved over the space of one year. However, the curriculum's influence can be felt on a much greater scale than this.

2.5.1 Curriculum dissemination

It could be argued that the nature and presentation of all curricula have, to a lesser or greater extent, an influence on subsequent student take-up, even though the effect may not be immediate or easily attributable to one specific cause. News of the extent to which a course is interesting and meeting the needs of the target group is transmitted to potential students and employers via the informal grape-vine of past students and others who have contacts with the department. Curricular factors, therefore, can never be dismissed from discussions regarding students' take-up even though potent socialising influences may also be at work both inside and outside the colleges. After mentioning these 'powerful forces' with regard to girls' choice of science subjects at school, HMI (1980) emphasised that 'nevertheless there are strong indications that the content of the science curriculum, and the ways in which the work is organised and the subjects are taught . . . could do much to influence the girls' choice of science subjects . . .'.

Swarbrick (1980) in her study of a group of women students taking the Open University Foundation Course in Technology (T 100) during 1978 explained how curricular information had influenced female take-up of the course that year. She had established by means of a questionnaire that 73 out of the 116 respondents had placed the technology course as only their second foundation choice, but that, 'once inside the Open University system it becomes possible for information about the course to percolate through and reach students informally. This may be a positive factor in its being the second choice, and one which the faculty could use constructively to attract more students from other disciplines by vigorous publicity.' Swarbrick highlighted this point by a quote from one of the women students and this is reproduced here:

'Listening to some technology tutors at summer school last year, I suddenly realised that technology was about subjects that worried me, they were so important but I felt so uninformed about them.'

In what ways could Further Education staff learn from this experience? Perhaps more encouragement could be given to students, particularly women, who were on courses of substantial duration (not day- or block-release) to spend some time during their first year 'shopping around' the range of curricular opportunities available in the college or polytechnic and allow them the flexibility to change courses or subjects if this experience had shown them that there was a more worthwhile alternative to their initial chosen subject. Other strategies might be found in developments to option structures, the introduction of more courses on a modular basis or the chance for students to take one or more subsidiary subjects near the start of their programme of study. Such improvements might enable women to sample, and to become more informed about, science and technology curricula with which they have previously had little contact or little success and so open up for them the possibility of choosing a non-traditional subject/career on which to concentrate. In her discussion on women's take up of the OU Technology course, Swarbrick commented that, 'ignorance rather than indifference may lie at the root of the problem'. If Further Education staff can do nothing else, therefore, they can ensure that there is an optimum flow of attractive course and career-related information to potential students. A pre-requisite for such a flow of information, however, is good curriculum dissemination between staff. A recent report written by staff at Blackpool and Fylde College of Further Education which was published by the Further Education Unit in 1980 has revealed that such dissemination is inadequate, even 'simplistic' and that this in itself is an inhibiting factor upon curriculum development.

2.5.2 Curricular content

There have been a number of suggestions that particular aspects of scientific curricula have a differing appeal for girls and boys or women and men. As mentioned previously, Ormerod (1971) and Ahlgren and Walberg (1973) found that the social implications of science were considered to be of far greater importance to school-age girls than to boys. While Brainard and Ommen (1977) in their study of college students concluded that, 'the women indicated a much stronger preference for instructional content involving qualitative and people dimensions, men demonstrated a stronger preference for numeric and inanimate content'. Further support for the argument that school and college science-based curricula should include a higher 'humanistic' content, in order to become more attractive to females, can be found in Swarbrick's study of women OU students taking Technology. It was discovered that the most popular reason for women choosing the course had been a desire to understand the environmental implications of technology and that once into the course the environmental and energy-related aspects of the curriculum had been found by the majority to be the most interesting. Undoubtedly these curricular preferences by women are a result of conditioning by socialising factors which lie rooted in the caring role which women have played in society over the ages. The high female participation rate in biological- and medical-related disciplines, as well as in home economics and domestic science, is a natural extension of this traditional role. It may be, however, that home economics and domestic science could provide one, as yet relatively untried, avenue through which women and girls can be motivated towards physical science. Kelly (1981) suggests as one strategy for improving girls' access into science the merger of domestic and physical science courses and it is understood that recent curriculum developments within the home economics area both in schools and colleges have led to the inclusion of more physical science topics.

Another curricular aspect which may ultimately affect students' enrolments on science-based courses is the aforementioned conceptual difficulty and presentation of the syllabuses. Certainly if, as seems the case, young women have not had the same opportunity as young men to come into contact with scientific skills and principles through informal learning means such as hobbies, then the inclusion into the curriculum of practical examples of the theory (perhaps with a people-oriented emphasis) may be especially beneficial to their confidence and progress at both school and college level. Indeed this factor was stressed by Kelly (1981) and HMI (DES, 1980(c)) noted that an 'over-theoretical' approach could be detrimental to children's attitudes to science. However, it has already been seen that women tend to prefer a more passive learning role than a participatory approach to study, probably because of their lack of previous experience in practical skills and in 'doing' rather than 'watching'. Whereas in schools they may have been accustomed to learning science in this way, the strong practical and applied emphasis of college science and technology courses, which at craft and technician level are more specifically vocational, requires full participation by students in laboratory and workshop activities. The fear of not being able to cope with these aspects of the courses may be an inhibiting factor on women's subject choice in post-school education. As a result of these fears the start of science and technology courses in Further Education may be rather more crucial for the women who do choose such non-traditional courses than for the men and college staff have commented on the project questionnaire and at interview upon the greater lack of confidence shown by women and, in some cases their greater drop-out rate, at this stage. Such negative experiences are transmitted, in ways described earlier, to potential women students.

2.5.3 Stereotyping in written materials

A further curriculum-related factor which might influence girls' and women's attitudes to science and technology is sex stereotyping in scientific literature and careers materials. Scientists and scientific activities are almost universally shown as being male or male domains, i.e. 'the scientist, he . . .'. This situation is compounded, as mentioned earlier, by the lack of female academic staff in science and technical departments and of female employees holding responsible jobs within industry who could point out to girls that women are succeeding in non-traditional spheres. There is, in addition, a dearth of textbooks written by women scientists and few readily-available articles which describe the contribution made by women to science over the years. Although the extent to which sex stereotyping in materials sustains the low participation rate of women in scientific fields has not been properly researched, this area is seen by many as one in which developments can be relatively easily made. Organisations are drawing up codes of practice, publishers are producing guidelines and a number of curriculum development projects here and abroad are devising new textbook and audio-visual materials particularly with regard to careers guidance. It is likely, however, that in terms of changes to attitudes and subject/career choices, the beneficial effects will be long-rather than short-term. Further discussion of such initiatives is given in Chapter 3 and a list of sources and materials in Appendix 3.

CHAPTER 3

Improving the Access

3.1 Introduction

*'There has been a great growth of interest in recent years in improving employment and training opportunities for women and relevant activities are evident to varying degrees in every sector of the economy. A lot of experience has been amassed. There is a need now to consolidate and share our experience.'**

Sir Richard O'Brian,
Chairman of the Manpower Services Commission.

While it is indeed true that there has been a growth of interest in expanding women's opportunities, as shown by the mountains of research material produced in recent years, when the practical initiatives which have resulted from this interest are considered, it is realised that they are relatively few in number and generally piece-meal in nature, particularly in the educational sectors.

The Manpower Services Commission, working with and through the Industrial Training Boards has perhaps been at the forefront of developments for women's vocational training and it is noteworthy that a considerable number of the conclusions and recommendations made at the end of the Commission's 1975 review of 'Training Opportunities for Women' (MSC, 1975) have since been implemented. However, even these programmes have to date tended to be small-scale and labelled 'pilot', 'temporary' or 'experimental' so that only a small number of women have been able to benefit from them, although this is gradually expanding as women's educational and training needs have become more clarified and the work has become more coordinated. The publication of the newsletter, mentioned previously, is one instance of such developments although there is a long way to go before dissemination of initiatives to reduce any disadvantage suffered by women reaches adequate proportions. The Equal Opportunities Commission has begun to find a role for itself as a clearing-house for information and research material and to tie together such information in published form through such outlets as 'EOC News', the new 'EOC Research Bulletin' and discussion papers on more specific topics. A pre-requisite to improvements in the dissemination of information is the availability of statistics on all aspects of education classified by sex, in order that the magnitude of the problem can be properly appreciated.

In this chapter a survey is presented of the various types of initiatives currently being made to improve women's access into science and technology and other 'non-traditional' fields. Small-scale activities are described first, followed by various types of outreach programmes which lead into curricular provision of an increasingly more substantial nature. This survey should be seen as a series of insights into the different approaches made to the problem of women's access, presented in a thematic manner, rather than an extensive coverage of all present initiatives.

3.2 Reducing Sex Discrimination and Stereotyping

3.2.1 Language

It has been said that 'the entire fabric of society tends to reinforce the tradition of sex roles' (Toner and Kingsbury in Ruina (ed), 1973), implying that it will require a massive effort to change the status quo or even to make a start upon this task. While it is difficult to see how, simply by removing the male pronouns and sex stereotypic pictures from a few textbooks, very much can be accomplished in the way of changing attitudes (in this context, women's attitudes to science and technology), it is likely that in the long run the cumulative influence of many such actions will have a beneficial effect. This feeling was stated by the President of McGraw-Hill Book Company in his introduction to the company's response to the problem (McGraw-Hill, undated).

'what is important is not particular forms of expression as such, but this pervasive sense of equality, personal worth and the unhindered development of potential'.

It is often only when a document such as the McGraw-Hill booklet is examined, that it is realised exactly how deeply ingrained in our language are gender-related words which through their usage seek to exclude half the population in some form of activity or function in life; for instance 'mankind', 'manpower' or 'man-made' or any of the job titles such as 'fireman' or 'foremen' which end in 'man'. Another common stereotyping problem in language is that of pre-fixing occupations or titles with the word 'woman' or 'lady' for referring to females of that walk of life or by placing 'ess' or 'ette' at the end, thereby implying someone out of the ordinary or not comparable with the norm. McGraw-Hill is not the only organisation interested in the elimination of sexism in written materials, the Schools Council, in cooperation with the EOC, is in the process of issuing similar guidelines relating both to the general use of language in its publications and materials and to the usage within specific subject areas. Davey (1980) has examined in some depth the whole question of the role of books, reading and libraries in the encouragement of girls to take up careers in engineering.

3.2.2 Visual means

Pictures, whether in books, on the screen or in posters are a very immediate means of communication and one which has led to unthinking misuse. Advertisements are particularly guilty of commonly portraying women in helpless, dependent, stereotypically 'feminine' roles. Careers materials are also in a sensitive position with this respect. It is now much commented upon that scientists and technologists have usually been portrayed as being male, thus leading either to resentment amongst girls or to their assuming that such jobs are not for them. Producing careers materials which do show girls and women in a range of scientific and technical jobs appears to be the most commonly used channel through which many of the professional organisations and training bodies are seeking to make developments. There remains, however, a considerable range of attitude and practice and it is still not uncommon to find girls portrayed as receptionists and secretaries 'looking on' whilst boys are shown fulfilling the more demanding tasks associated with being a scientist or engineer. As one leading member of a professional society remarked, 'we *are* positively discriminating towards women by over-representing them in our careers literature; in practice there are proportionally far fewer actually working in the profession'. On the whole the professional societies appeared less convinced than the government-backed training bodies that there should be any form of positive discrimination for women who enter, or who might enter, their profession. They tended to stress that their main concern was to attract the most talented students and employees irrespective of sex.

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* Introductory article in 'Women and Training News' (1980). Issue No 1. Inter-Board Liaison Group on Training Opportunities for Women.

3.2.3 Careers materials

An alternative way of reducing stereotyping and encouraging girls/women towards science and technology through the careers guidance medium is by producing special materials aimed at their particular interests and information needs. In the light of past comments it is not surprising to find that such initiatives are most likely to have been implemented by the Training Boards and the MSC which produces a range of special leaflets and posters to encourage girls and women to take advantage of YOPS and TOPS schemes and technical training in general. The Engineering ITB has also been active in this field and produces materials which inform girls about the different levels of jobs available within the engineering profession, as have the Women's Engineering Society, the Electrical Association for Women, and in America the Society for Women Engineers which in 1973 co-sponsored a national conference entitled 'Career Guidance for Women entering Engineering' (Fitzroy (Ed), 1973).

In order to reduce sex stereotyping in schools, provide better careers information on science for girls and so encourage more of them to consider science-based occupations, the 'Girls into Science' 'affirmative-action' project has been established in Manchester under the sponsorship of the SSRC*/EOC Joint Panel on Women and Under Achievement, and is one of several such initiatives. The project involves the arranging of teacher workshops, pupil testing, the development of careers and teaching materials and the setting up of a 'Visiting Women Scientists Programme'. Another EOC funded project at the Counselling and Career Development Unit at Leeds University has developed a unique in-service course for teachers which is also aimed at reducing sex stereotyping in education.

3.2.4 The EOC and sex stereotyping and discrimination

In order to help in the design of better, unstereotyped careers materials generally the EOC has itself published 'A Guide to Equal Treatment of the Sexes in Careers Materials' in addition to 'Breakthrough, a pictorial record of five years' progress towards sex equality in employment'. This optimistic booklet comprises a series of role-model presentations of those, women and men, who have succeeded in non-traditional occupations. A second booklet 'Fresh Start' is aimed at expanding the career aspirations of adult women who wish to return to work after a break.

The EOC publishes several more guides which seek to reduce sex discrimination and related problems in education generally and these are cited in Appendix 3. There are two sets of guidelines available, however, which are particularly aimed at the Further Education sector. The first, 'Sex Discrimination and the Equality of Opportunity', deals with the question of equality in those spheres, such as course structure and examining procedures in which the CNAA** has an influence. The second, 'Equal Opportunities in Post-School Education', which partly covers the same ground, is an important and detailed document which is commended to all those who have an interest in providing equality of opportunity in Further Education.

The guide offers recommendations for a wide variety of instances in which discrimination might occur, whether direct or indirect, deliberate or otherwise, and covers, for example, careers materials and publicity, entry regulations, course design and teaching and the development of new courses. As many of the recommendations have direct relevance to the question of improving women's access into science and technology, a selection of the most pertinent guidelines are collected together in Appendix 4 of this report.

In Appendix 3 a reference list of initiatives to reduce sex discrimination and stereotyping is provided. For further information the reader is referred to 'Women and Education' (Special Issue, 1980), to 'EOC News' and to Kelly (Ed) (1981).

3.3 Financial Incentives

Financial incentives in the form of scholarships and training awards are one of the ways in which government agencies and other organisations can, through essentially artificial means, create a precedent that, by way of acting as a focus of attention and publicity, will influence others to follow. It might be speculated that if such actions are successful there will come a time when artificial inducements are no longer necessary and 'the ball will continue to roll'. Such has been the experience of the EITB who, in 1976 established the 'Girl Technician Scholarship Scheme' which ran for three years and was aimed at showing parents, employers and young women that 'engineering is good for girls and girls are good for engineering'. After the three years were completed and the scheme deemed successful it was decided that the time had arrived to remodel the programme for a new situation. The old scheme had been a success on several levels; most of the scholarship holders had completed their training and so entered the industry, providing role models for others and the scheme had helped to demonstrate that 'a large number of girls of very high potential is anxious to find out what engineering has to offer as a career. At one time the favourite ploy of the obstructionist was to ask the question "But do girls really want to become engineers?" ' ('Industrial and Commercial Training', 1979).

The new scheme devised by the EITB differs from the old in that, instead of the selected young women starting off on the payroll of the EITB and transferring to companies as their training progressed, special grants will be made available to firms who recruit young women as technicians and technician engineers over and above their normal intake of trainees. This new scheme will be, therefore, from the Training Board's angle more cost effective and enable them to sponsor a greater number of candidates.

Women technician engineers have also benefited from an initiative made by the Caroline Haslett Memorial Trust in conjunction with the Institution of Electrical and Electronics Technician Engineers who for the last three years have made the 'Girl Technician Engineer of the Year Award' to an outstanding and recently qualified woman technician engineer. The Award which is presented by a national figure and receives widespread publicity is offered by the sponsors in order to: *'focus attention on the increasing opportunities for girls as technician engineers in the electrical and electronics industries in the hope that, the*

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* SSRC – Social Science Research Council.

** CNAA – Council for National Academic Awards.

successful applicants will by their example, encourage other girls to follow similar careers.'

The Caroline Haslett Trust is also active in encouraging young women to enter the engineering profession at professional level by awarding annually a limited number of scholarships to girls who are expecting to study for a university degree in engineering, mathematics or the physical sciences. The Trust, in conjunction with the Amy Johnson Memorial Fund, has also begun to offer a scholarship for a girl wishing to study aeronautical engineering. On a much larger scale the EITB is also concerned with providing the profession with more women engineers. The EITB through its 'Engineering Awards for Women' offers 50 selected young women who are about to embark upon a first degree course in engineering a tax-free bursary of £500. The candidates are expected, however, to have already demonstrated their intention to enter the profession by having obtained the 'sponsorship' of an engineering company for their proposed course of study.

While the main thrust of the EITB has been towards increasing the number and quality of entrants into its industries, one or two of the Industrial Training Boards have been turning their attention to the career development of women by encouraging women to move from shop-floor jobs to supervisory or managerial positions. Interestingly, while the Chemical and Allied Products ITB scheme has had, apparently, few women takers, the programme developed by the Food, Drink and Tobacco ITB has had considerable success under the direction of their newly-appointed 'Training for Women Co-ordinator'. The FDTITB offers grants to companies to help finance an agreed programme of training which will help the woman make the transition to her new and more demanding job. The scheme is well publicised in the trade journals relating to the differing sectors of this diverse industry. Other organisations involved in this type of special provision are The Industrial Society with their 'Pepperell Development Course for Women', the West Midlands Engineering Employers Association and Ashridge Management Centre which has a major research project under way in this area.

It is difficult in a time of economic recession to foresee many developments in the provision of special finance for any one minority group, whether it be women in the technical professions or anyone else, other than the unemployed. In a report by a working group convened by the Special Programmes Division of the MSC (MSC, 1979) it was stated that in 1978/79 of those unemployed receiving sponsorship by the MSC:

in the Job Creation Programme, 24 per cent were women
in the Special Temporary Employment Programme (STEP), 25 per cent were women
in the Youth Opportunities Programme (YOPS), 50 per cent were women
in the Work Experience Programme, 56 per cent were women

With regard to the 'Training Opportunities Scheme' (TOPS) which is aimed at those of age 19 years or over who have been away from full-time education for more than two years, the MSC has provided the project with information which suggests that since 1975 over 40 per cent of successful trainees have been women and that:

14 per cent on higher level science and technology courses were women
7 per cent on courses in the electrical/electronics field were women
24 per cent on courses in computer operating, programming and systems analysis were women

The MSC in one instance also provides special sponsorship for selected women to attend the 'Wider Opportunities for Women' (WOW) bridging courses run at several colleges around the country. For all other educational/vocational courses (outside the very few such as the WOW courses which are restricted to one sex under Section 47 of the Sex Discrimination Act) women and men can apply equally for grants where necessary although mature students are now competing for the decreasing pool of discretionary awards being made available.

One possible source of finance for funding special programmes for women is the Social Fund of the European Community. In 1979 it was stated by the Director (Stabenow, 1979) that the resources available for such projects were as yet underused and a greater number of applications from member countries were called for. From discussions with college staff and other contacts during the life of this project it appeared that there was a general lack of knowledge (a) that such finance was available and (b) how and where to apply. It is a pity that a greater use of Social Fund resources has not been made to open up women's opportunities in Britain since, as the quotation of Sir Richard O'Brian given at the start of this chapter suggests, 'a lot of experience has been amassed' in recent years. This feeling has been echoed by the EOC ('EOC News', 1980/81) in its response to the MSC's recent review of training, saying that the MSC should not only encourage a greater use of EEC funds but should provide incentives 'to ensure strategic provision for girls and women in key skills training'.

3.4 Informing and Encouraging

There are a number of possible routeways through which to inform and so encourage women to consider science and technology as viable careers. The careers medium has already been mentioned in this context in relation to the design of materials which portray images of women as well as men engaged as scientists and technologists in a variety of situations and to the production of careers literature aimed specifically at women. Whatever the avenue open to educationalists there remains the dilemma of whether or not to make special provision for women or whether to fashion the schemes to the encouragement of young people or adults towards science and technology in general. From the project's survey it does appear that the most positive and immediate results with regard to women have been achieved rather through efforts which have been clearly and carefully targetted at women than through initiatives of a more generalised and diffuse nature. There does not, for instance, appear to have been a marked pay-off for Further Education science and technical departments in terms of increased women students through link courses, departmental open days or careers conventions to date.

3.4.1 Improving the school-industry interface

One group of initiatives which may in the future produce worthwhile results are those which seek to establish and improve school-industry links. Through such ventures school children are helped to appreciate the significance and challenge of engineering careers in industry, members of companies are provided with a direct relationship with individual schools and can meet with teachers to discuss school curricula and examination syllabuses and how they relate to local industry, and teachers can be provided with the opportunity, through a short secondment in industry, to gain a closer understanding about technology and technical careers and so influence and advise their pupils. These initiatives are growing in number and are diverse in nature having developed under the auspices of such bodies as the Department of Industry (through its Industry-Education Unit), the Science and Technology Regional Organisations (SATROs) and the Industrial Training Boards, not to mention those which have begun on a single company to school basis (Schools Council, 1980). It might be anticipated that any scheme which brings technology and industry into closer contact with young people before they have made their final career choice, whether it be through a school industry link scheme or through YOPS or the Work Experience Programmes for example, will ultimately provide an impetus for women to consider a wider range of career options than previously, although any positive results from these are not likely to be seen immediately. Members of one or two of the Industrial Training Boards, whose main initiatives are for the 16-19 age group, felt that this would be the case in the future.

3.4.2 Conferences, workshops and other outreach activities

Another means of informing and encouraging women without having to design and finance special courses is through the organisation of conferences, workshops and seminars several of which, aimed at awakening the general public's interest in expanding women's opportunities, have been held during the last year or so. The influence of such activities on the target group is likely to be indirect; those who attend these meetings tend to be the better educated, those already within the educational system. However, the attitudes of school and college staff are widely recognised as having a major influence on those of the students and a number of projects, both in America and Britain, have explored ways of informing and changing the attitudes of the several interested parties involved with the problem.

3.4.2.1 America

One example of such a multi-pronged approach has already been cited: i.e. the programme entitled 'Multiplying the Options and Subtracting Bias' at Wisconsin-Madison University which is specifically aimed at the problem of girls' poor participation rate on mathematics courses. The programme consists of four different workshops, one each for male students, mathematics teachers, school counsellors and parents for which special audio-visual materials have been produced. A project evaluation showed that only three months after the first programme had been held there was a noticeable increase in female enrolment in mathematics and a change in attitudes of the girls. A further example of how American college staff are becoming involved in promoting women's access into technical careers through conference activities is described below (Rudnick and Wallach, 1979).

The programme, which was designed, presented and co-sponsored (along with a local newspaper, thus ensuring excellent publicity) by college staff at Wentworth Institute of Technology in New England, consisted of two conferences, one for school counsellors, careers personnel and mathematics and science teachers, and one for women students themselves. The first conference was aimed at a variety of school staff because it was believed that, 'a coalition of counsellors and teachers in a school would create a supportive team that could effect change'. The beneficial effect of staff other than science teachers on such teacher conferences was commented upon by Whyte and Smail (1980) who found that, in setting up school-based workshops to reduce sex stereotyping and so encourage girls to choose science, the presence and attitudes of pastoral-care teachers and non-science staff tended to reduce hostility amongst the scientists who tended to be 'distrustful of sociological and psychological as opposed to biological explanations'. Both conferences in the programme designed by Wentworth Institute had the following three, major components:

i. **Work Stations** set up by educational institutions and local companies with equipment operated by women and allowing the participants some 'hands on' experience.

ii. **General Session** which included a keynote speech followed by a panel of women technicians representing 'a mix of academic ability, backgrounds, ages, marital status and race' who described how they had arrived in their present jobs and their experiences.

iii. **Workshops, Panels and Seminars** which were 'balanced between those that attempted to address the more subtle psychological implications of occupational and educational segregation and those whose primary purpose was informational'. The following groups were set up:

'Maths and Science Anxiety'
'Exemplary Programmes Promoting Technical Careers'
'Students Helping Students cope with Non-Traditional Choices'
'Sex Bias in the Classroom'
'Labour Market Trends and Occupational Outlook for Women in Technical Employment Fields'
'Developing Parent Awareness of Changing Career Options for Women'
'Educational Paths to Technical Jobs'
'On-the-Job Training Programmes'

In summing up the rationale behind such programmes Rudnick and Wallach concluded:

'Programmes like these constitute but one of the steps we must take to convince girls that technical careers are satisfying and represent well paying job options for them as well as for boys. As trustees of technical education, we have a responsibility to society to act as agents of change. Less altruistically, the stability of our future enrolments depends on our being able to develop a talented and heretofore untapped reservoir of students.'

Other American programmes have taken an even more wide-ranging approach through organising a variety of curricular and extra-curricular activities such as the 'Female Access to Careers in Engineering Technology Exemplary Project in Vocational Education' (FACET), established at Trident Technical College in South Carolina (Caughman, 1978). This consisted of 'public awareness materials, disseminated through three local counties'; talks to local schools; personal interviews with women wishing to enrol in engineering technology; special selection for potential women students; follow-up meetings for women students once enrolled; the design of new curricula by engineering, social science and counselling staff aimed at interesting women; consultants brought in to deal with sex bias and sex stereotyping in the courses and classroom and the provision of remedial mathematics classes. Over the project year women's enrolment rose from 6 to 13 per cent of the total and it was concluded that 'introductory courses are an effective means of interesting women in these areas, but equally important is a community outreach effort', a need echoed by Kelly (1981). The provision of such all-encompassing initiatives is facilitated in the United States by powerful equal opportunities legislation through which federal funds can be made available to fund projects (Stoney and Reid, 1980), but equally there appears to be a greater consensus amongst

American educationalists that positive discrimination is needed in order to promote the entry of women into non-traditional spheres. Such special provision for women and other so-called 'disadvantaged' groups is now an accepted part of American college life.

3.4.2.2 Britain

In addition to a sprinkling of general conferences there are few British outreach activities in this area which seek to include, or are aimed at, girls and potential women students. One or two colleges, polytechnics and universities have begun to arrange open days especially for women, such as those held by the School of Engineering at Hatfield Polytechnic, by one of the Science and Technology Regional Organisations in conjunction with a university (DES, 1980 (c)) and a special workshop was held recently at Imperial College, London. There is, however, a growing number of localised projects, on a smaller scale to that established in Manchester, which are being set up by school staff to encourage a higher proportion of their girls to choose science, such as that entitled 'Girls for Physical Science' (Hearn, 1979). In this instance staff have made a point of discussing science and career implications of studying science with girl pupils, raising the subject with parents through special meetings, involving the careers guidance officer and non-science staff and utilising the services of girl scientists themselves. In his concluding remarks on this project Hearn commented, 'our approach has been a simple one – to raise the problem with all concerned and then to let the pupils decide. We have cultivated an atmosphere which gave the girls confidence to try'. For information on similar projects the reader is referred to Kelly (Ed) 1981, 'Women and Education' or 'EOC News'.

Her Majesty's Inspectorate discovered (DES, 1980 (c)) that in schools where enlightened science teaching was taking place there was always plenty of help for those with special difficulties; in one or two instances this was organised through clinics or workshops, similar to the mathematics and science 'anxiety' clinics already established on American school and college campuses. Only one project in Britain has been identified which has specifically been examining the problem of adult women's anxiety in taking science courses within Further Education (Davies, 1980) and how this can be remedied. These and related initiatives can be expected to have a beneficial influence on women's enrolment in science in years to come.

3.4.3 Courses which inform and encourage

Curricula which are designed as general information-giving, counselling and confidence-raising exercises with women in mind are not so scarce as might be imagined and are, in fact, steadily growing in number (v. Miller, 1980; Stoney and Reid, 1980; 'Directory of Further Education', 'Second Chance' Section, 1980). Those which specifically aim to inform women about science and technology, however, are still a rarity. Some of these courses fall within the umbrella category of 'bridging courses'; courses which help students who are often adults to take the first step towards a new or first career but do not in general aim to prepare them for specific vocational goals. Courses that are aimed at providing women with the educational and vocational skills to enter science and technology, rather than at information-giving, will be described in the next section.

Of the bridging courses which do seriously attempt to broaden women's career aspirations, the 'Wider Opportunities for Women' courses mentioned previously, which are sponsored by the MSC are some of the most noteworthy. Approximately ten were running in colleges around the country in the 1979/80 academic year. These short courses which follow, to a certain extent, earlier American models (v. Stoney and Reid, Chapter 5, 1980) are almost unique in Britain by enabling women to have job sampling experiences backed up by counselling, aptitude testing and group discussion periods on job opportunities and related problems. Such curricular components are important for women if, as is often suggested, they are poorly informed and motivated towards technical careers. Evalutions of American programmes which have comprised work experience components have concluded that they have been key elements in successful courses. It should be mentioned that, in addition to the WOW courses, tutors of several other British bridging courses are attempting in some way to provide women with introductory, educational experiences in mathematics, science and technology, although it has been found that where this is carried out through option structures, the women participants tend to choose the traditionally 'feminine' topics (v. Stoney and Reid, 1980).

Another important aspect of bridging and other information-giving courses, from the point of view of women who are poorly educated and have low aspirations, is that the students are provided with the opportunity of meeting successful female role models from industry and the academic sphere. As mentioned in Chapter 2, role-model influences have been shown to be potent agents for changing aspirations especially amongst the young. This has been taken into account by the staff involved with the 'Girls into Science' project who, as one of their 'intervention strategies' are setting-up a 'Visiting Women Scientists Programme' for schools in the Greater Manchester area. The role-model aspect has also been considered a vital component of the rare curricular initiatives currently available for informing and encouraging young women towards technical careers.

As the third of a series of successful initiatives made by the EITB with the aim of bringing more talented women into technology and so improving the overall pool of qualified engineers, the 'INSIGHT' courses form an exemplary model for others to follow (EITB, 1979; 'Industrial and Commercial Training', 1979). These one-week residential courses held in the summer at universities are aimed at introducing the engineering profession to more able female students who are taking science and technology 'A' levels. The philosophy of the Board is that, if the more able girls can be encouraged to pursue a career in technology, then those of more average ability will feel able to follow. In a discussion with a senior training officer of the EITB, it appeared that the scheme had met with some initial resistance from school staff but, with the help of sustained publicity and the success of the first INSIGHT courses in 1979, the early problems have been overcome and the courses have expanded in number and continue to be oversubscribed. An evaluation of the outcomes of the early courses has shown that a surprisingly high percentage of students who have taken an INSIGHT course have embarked upon further engineering training, indicating yet again that there is a considerable number of potential female engineers who are simply awaiting suitable opportunities and encouragement. This same training officer identified four curricular aspects which were considered to have led to the success of the INSIGHT courses:

i. Extensive publicity, both before and after the courses,
ii. A carefully worked out programme of visits by the students to employers which ensures that they will have favourable first-hand experience of industry and the day-to-day work of engineers,
iii. Imaginative course work and information-giving sessions,

iv. Tutoring, which utilises the services and experiences of young, practising women engineers.

On a smaller scale, and organised through the 'Schools-Industry Link' scheme a four-day course ran in 1979 which was aimed at introducing sixth-form girls of good mathematical ability to the engineering industry. The course was located at the Ferranti Education and Training School at Hollinswood near Manchester and catered for 20 girls from local schools, ('EOC News', 1979/80).

3.5 Access Through the Curriculum

3.5.1 Courses of an educational nature

In this section a survey is presented of courses available in Britain and abroad which are either geared specifically to the training needs of women entering science and technology or are available to help those of both sexes who have limited scientific knowledge and insufficient background experience. Their aim is to provide such students with access into mainstream curricula and thereafter into careers. As it has been seen at the start of Chapter 2 that young women tend to leave school having studied less science and technology than young men and achieved less well in the examinations, introductory courses offered within the Further Education Sector are an important means of overcoming inadequate school-based education and serving as a means of access for those who have had a change of attitude toward science and technology since leaving school and want to explore the possibility of careers in these fields.

In terms of special provision for women, there are few British precedents to describe. Southwark College in Inner London has been experimenting with some success with a part-time 'Return-to-Study in Science' course for mature students and a full-time 'Careers Foundation Course in Science' which is geared to helping those who already have a basic scientific knowledge (perhaps gained through the part-time opportunity) to increase this knowledge up to a standard which will enable them to gain entry into a degree course. The College has built up links with a London polytechnic so that successful students can have an automatic right of entry into Higher Education. These courses which, when visited by the project team in 1979, had an all-woman take-up, although overall numbers were relatively low, concentrate on chemistry and biology, with back-up mathematics lessons, study skills and counselling. It will be interesting to see whether these as yet unique courses, which have generated considerable interest, can find a continuity of student take-up in coming years to ensure their survival, and whether they will be replicated elsewhere. However, as mentioned in Stoney and Reid (1980), science and technical departments have, for various reasons, not been at the forefront of making developments for adult students.

Another curricular initiative for mature women students is currently under way at Hillcroft College, the only long-term residential women's college in the country. It was hoped that this course would provide a thorough introduction to science and technology for women with few previous qualifications and so promote their career prospects. However, having failed to attract government funds or EEC finance through the Social Fund (because of restrictions on the age of students and type of course offered) for the course in the immediate future, it is planned that a more restricted, but still viable, programme will start in September, 1981. While this revised curriculum will still provide an introduction to science, the main emphasis will be on numeracy and 'the mathematical techniques needed for women to play an increasing and responsible part in the microtechnological age' (Cockerill, 1980).

Other examples of introductory provision which have an educational rather than a strictly vocational outlook are the 'Polymaths' and 'Polyphysics' courses run by a number of the polytechnics for those who have only a basic knowledge of these subjects. These are one to two year courses which provide access into Higher Education. As they involve students in a great deal of private study they are really only suitable for those who already possess a considerable degree of motivation. The polytechnics and colleges of higher education are also showing an interest in increasing the flexibility of their provision by offering an increasing number of courses of a modular nature, i.e. modular degrees and Dip.HE courses. At some institutions students can build up credits for their degrees by combining arts, science and technology options, such as at Hatfield Polytechnic for a BSc in Combined Studies. Students are often able to take the science options without having 'A' level qualifications in that subject, sometimes with hardly any qualifications in science at all. Once embarked upon such a programme of study students are open to influences (as mentioned earlier in relation to the Open University) which may lead them to choose non-traditional options later on in the course once they have gained their confidence in familiar subjects or find that study of the subject which they wish to specialise in would benefit from their taking one or more science options as back-up. In Chapter 5 a case is described in which such influences would appear to be at work in encouraging women to choose science.

At the lower end of the academic spectrum, further education colleges are now offering two-year 'O' level or three-year 'A' level programmes of study in science for those of poorer than average backgrounds. In the first instance, the 'O' level programme offers students the necessary mathematics and science to enter technician-level courses along with some help with literacy. The opportunities are sometimes labelled 'Pre-Technology' courses. The extended 'A' level courses, meanwhile, provide the chance for students to take extra 'O' levels and lead them into advanced level study at a steady pace. Groups of 'O' and 'A' level options are sometimes packaged together to form a programme which is attractive to those who wish to gain entry into a particular profession. It is now becoming the vogue for colleges which are local study centres for the Open University to offer part-time 'Pre-Open University' courses linked into the OU's various Foundation curricula. These courses are taught with an emphasis on the acquisition of good study techniques and provide people who may be low on confidence with new curricular approaches to familiar subjects which they might have been taught at school in an unimaginative manner and not liked. Such courses would seem to be good opportunities for women to try themselves out against non-traditional subjects. However, extensive publicity is all-important for these 'first step' curricula in order to attract those, especially women, who might gain most benefit.

3.5.2 Skills-oriented courses in Britain

In terms of technical training, opportunities specifically aimed at women are few and far between at the moment. The EITB has run several 20-week 'Skills Training' courses designed to provide 'an induction to a variety of tasks at operator level appropriate to the engineering industry' (MSC, 1979) which include assembly work, electrical wiring and soldering, and the operation of capstan lathes and other machine tools in addition to life and social skills and some further education. One of these courses at Perry Barr, Birmingham was designated for girls but it is not known whether any more single-sex courses will be offered in the future as these were experimental ventures. Certainly it would seem that there is a need for some initiatives for women at operator and craft level where the smallest numbers of female recruits currently exist. It is interesting to note that in the MSC's review of training opportunities for women in 1975, one of the concluding statements claimed that, 'the Training Services Agency wishes to encourage girls to go into craft training and will keep the progress made under review'. There is little evidence that as yet this has been the case.

In addition to rare instances of positive discrimination, there are a number of other avenues open to women who want to enter science and technology via practically-oriented courses, and might do so if more, and more appropriate, publicity were given to them. Quite a number of engineering departments run one-year 'Foundation' or basic-training courses at both craft and technician level and science departments may offer science laboratory courses at a low or introductory level which also tend to be taught from basic principles. In 1980 the Union of Educational Institutions (now part of the West Midlands Regional Advisory Council on Further Education) devised a new 'Science Laboratory Skills' certificate course which is now being implemented by a number of colleges and which offers students a more practically-oriented approach to laboratory work. It is intended that it should be 'particularly relevant to the needs of part-time mature entrants to employment as Science Laboratory Assistants' as well as being preliminary or supplementary to other technician courses validated by CGLI* or TEC.** As such, it is likely that this and similar curricula will be particularly useful for women who lack scientific qualifications by leading them into technician-level courses through a skills-learning rather than an academic approach. At a somewhat higher level the TOPS technician courses are available for those with only a basic science and mathematics background, and have the advantage of offering students sponsorship while they study. Before starting a TOPS course students can improve their background education through a short pre-TOPS scheme for which MSC finance is also available. In addition the MSC, in conjunction with colleges, sponsors a variety of short courses for the unemployed in the locality of the college. These courses are geared to the local employment/industrial situation and are ephemeral in nature. They offer several weeks of basic training with some theory of a low level and are seen as 'taster' courses for the unemployed, not in themselves fitting them for a job.

3.5.3 Skills-oriented courses in America

In the United States, where women have also been in a small minority in the skilled trades, pre-apprenticeship schemes for women only are growing in number in order to try to rectify this situation. Several research projects have been funded to examine the problems that women face when entering these occupations (Kane et al, 1977; Marshall and Herman, 1978). The projects' findings discovered that:

i. Because of poor technical backgrounds women who were applying were failing the entry tests.
ii. It was only after some experience in the workforce, usually in a lowly-paid job that women began to realise that the skilled trades were viable career possibilities and by this time it was too late to apply.
iii. Women had inadequate knowledge of the trades and tended to apply for the most well-known options where competition was fiercest.
iv. They were unfamiliar with the tools used, the work procedures and the terminology.
v. They had difficulty in obtaining a job which is required before apprentice training begins.
vi. There was a high drop-out rate amongst women entering apprenticeships.

An example of one such pre-apprenticeship course which has been established to cope with these problems is described below (Mitchell, 1977). The programme was organised by Lansing Community College in co-operation with local manpower agencies and unions and initially was geared to the training of 20 women to become electrician apprenticeships. The 17-week course was aimed at providing the selected students with the necessary skills and knowledge to be accepted by the union as apprentices, and comprised 25 hours of classroom and laboratory work per week in mathematics, metrics, physics, blueprint reading and fundamental electricity. 'My philosophy', states the course tutor, 'is to provide women with the same background or work experience that a man would have'. The college placement service was available to help the women find jobs prior to becoming apprentices. Similar courses to that outlined above also include assertiveness and physical fitness training in order to help them to come to terms with the rigours of the job once they have been accepted, and like most American programmes they include a counselling element.

In terms of preparing women for technician training, the American schemes appear to be a mixture of the first EITB training scheme for women and of the pre-apprenticeship programmes mentioned above. The women receive financial support for one or two years under some federal funding policy and are placed in companies for part of the training period working as trainees but in addition receive further education, testing, counselling and help in finding permanent jobs. One such course is that entitled 'New VIEW' (New Vocational Education for Women) at Foothill-De Anza Community College in California (Davidson and Shoenhair, 1976) but there are many others which have had favourable outcomes and can provide pointers as to how similar provision in Britain might be developed.

How then can women be encouraged to utilise new and existing pathways into the scientific and technical fields? Publicity aimed at potential women students is an obvious key, but also it would seem that there is a need for closer co-operation between school careers experts, college departments, training bodies and industry so that all are alerted to the facts that such channels exist for women as well as men and can help them take the first step. With regard to making special curricular provision for women at entry-level it appears that there is still scope, especially at technician and craft level, for more experimental courses to be run but, as stated at a recent conference on the relevance of science and technology to the women's movement held by the British Society for Social Responsibility in Science (THES, 1980):

'Government programmes aimed at enticing more young women into science and technology are likely to prove unsuccessful if they are geared to turning out carbon copies of the average male scientist.'

while an American educationalist (Caughman, 1978) commented that,

'Introductory courses should utilise experimental laboratory activities and should give participants the opportunity to see and meet women at work in non-traditional careers. Support services such as tutoring and counselling should be readily available to all participants.'

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* CGLI – City and Guilds of London Institute.

** TEC – Technician Education Council.

3.6 Strategies

As a conclusion to this chapter and also to provide a source for discussion, the most commonly suggested strategies which might help to improve women's access into science and technology are gathered together in tabular form for easy reference (Table 3.1). It can be seen from this table that there are numerous recommendations, some all-encompassing while others, such as several of the teaching strategies, require only acceptance of their value. The school-based suggestions made by HMI (DES, 1980(c)) and Kelly (1981) have been included in this list where it can be seen that they might be of relevance to the college situation. Of the five main sources used for the construction of this table, the most pertinent recommendations from the EOC guide are outlined in more depth in Appendix 4, while those of HMI and Kelly have been mentioned at intervals throughout this report, and the suggestions made at the American conference relate mainly to organisational developments. There remains, therefore, the MSC recommendations which of all the five are the most specific to the question of women embarking upon science and technology courses within British Further Education. The working party of the Special Programmes Division of MSC, which evaluated the training needs of women, in their conclusions stressed the importance of the quality of the opportunities made available as much as provision of the opportunity itself, on the grounds that girls and women 'may be in particular need of help in the transition from school or unemployment to work' (MSC, 1979). Under the heading of 'Work Experience for Young People' a call was made for 'careful and adequate induction' and where possible the opportunities for job sampling. The group also emphasised that each opportunity should encompass 'a wide range of different kinds of experience', that the matching of trainees to opportunities 'should take full account of individuals' skills, abilities and potential' and be planned so that individual learning needs could be identified and met. Interestingly it is recommended that trainees should work in mixed groups but that there should be 'adequate and sympathetic supervision and support' coupled with the availability of counselling. With regard to the provision of further education courses, the importance of life and social skills for both sexes was stressed but also the need for women to have good access to further education in general as this could provide them with compensatory education, confidence building and help them in mastering new skills and in a general broadening of aspirations. In this light it was also mentioned that courses should not rein-

Table 3.1 Summary of Strategies Suggested to Promote Women's Access into Science and Technology

Strategy	Source/s of Support and Comments
A. ORGANISATION	
1. Improve Careers Guidance Materials Aimed at Women	ITBs; Professional Organisations; 'Girls into Science Project'; American Conference; Kelly, MSC.
2. Improve Course-Related Publicity Generally	EOC Guide; American Conference.
3. Improve Outreach Activities/School-Industry Links	EOC Guide; American Conference; HMI; ITBs; Department of Industry.
4. Revise/Scrutinise Admissions Policies	EOC Guide; American Conference.
5. Establish Scholarships/Provide Financial Incentives for Women	EITB; FDTITB; CAPITB; Caroline Haslett Trust/IEETE; Society of Women Engineers (America) US Federal Policy; Swedish Government Policy.
6. Appoint Coordinator to Oversee Initiatives/Provision of Equal Opportunities	FDTITB—'Training for Women Coordinator'; American Conference; EOC fulfils this role generally; MSC and most ITBs have staff with responsibility in this area.
7. Keep Accurate Statistics by Sex	American Conference; EOC.
8. Timetable More Courses within School Hours	EOC Guide; MSC; Suggested by many tutors working with adults (Stoney and Reid, 1980).
9. Run More Courses of a Modular Nature	EOC Guide; MSC; Most courses in American colleges/universities are modular—this is steadily increasing in UK.
10. Help Women on Non-Traditional Courses to Make Contact with Other Women	American Conference.
11. Provide Child-Care Facilities	EOC Guide; MSC.
12. Combat Sex Stereotyping in Education Generally	EOC; MSC; Kelly; American Conference; Several intervention projects; Schools Council; CNAA; McGraw-Hill.
13. Change Attitudes of Teachers, Lecturers and Peers	Fennema (1980); 'Girls into Science Project'; American Programmes, Section 3.4.2.1.

Table 3.1 (continued)

Strategy		Source/s of Support and Comments
B. CURRICULUM AND TEACHING		
1.	Make/Have Made Special Curricular Provision for Women (single-sex classes)	Kelly; American Conference; MSC and EITB under Clause 47 of Sex Discrimination Act (WOW and INSIGHT courses); Tutors involved with bridging courses aimed at women (Stoney and Reid, 1980).
2.	Develop More and Varied Introductory Courses	EOC Guide; American Conference; MSC.
3.	Involve More Women Role-Models/Teachers	EOC Guide; American Conference; MSC.
4.	Provide Supportive Classroom Atmosphere (women lack confidence/men may intimidate young women)	MSC; Kelly; HMI; Research findings, Chapter 2.
5.	Extend Counselling Provision for Those Studying in Non-Traditional Environments	EOC Guide; American Conference; MSC.
6.	Provide More Job Sampling Opportunities Within or Outside the Curriculum	MSC; American Conference.
7.	Institute Compensatory Classes in Scientific Skills	MSC; Kelly; EITB Skill-Training Courses; 'Maths/Science Anxiety Clinics'.
8.	Reduce Theoretical Aspects of Courses/Teach more Practical Examples of Theory	Kelly; HMI.
9.	Raise the Humanistic Content in Science Courses	Kelly; HMI; Conclusion of several attitudinal studies, Chapter 2.
10.	Utilise/Develop More Teaching Materials which Include Females and Topics of Female Interest	Kelly; HMI.
11.	Value Women's Qualities, i.e. Good Report Writing and their Meticulousness	Kelly; HMI.
12.	Encourage Girls not to Drop Science at School	Kelly; HMI; Those educationalists supporting the 'core curriculum' lobby.

Sources:

American Conference: suggestions made by Workshop Three of conference 'Women and Engineering' (Bugliarello (ed), 1971).

EOC Guide: 'Equal Opportunities in Post-School Education'.

HMI: DES (1980) 'Girls and Science'.

Kelly: Kelly, A (1981) Chapter 20 'Retrieving the Missing Half' in Kelly (ed) 'The Missing Half'.

MSC: MSC (1979) 'Opportunities for Girls and Women in the MSC Special Programmes for the Unemployed'.

force traditional stereotypes and, very pertinent to the present project, that :

'encouragement should be given to the provision of further education specifically designed to compensate for a lack of maths and science or to provide an introduction to science and technology. These courses may well benefit school-leavers of both sexes, but will often be needed particularly by girls.'

It can be seen from this chapter, therefore, that a variety of initiatives are being made on behalf of women by a wide range of educationalists, government agencies and other interested parties. The special programmes which have been established by American colleges and universities are of relatively long standing whereas almost all British initiatives are of recent origin so that there has scarcely been time to evaluate their outcomes. The present trends suggest that women's enrolments on science and technology courses, particularly enrolments of an applied nature, are increasing very gradually; the next few years will reveal whether these already-instigated actions will produce any really noteworthy results. The lowest participation rates by women are to be found at the lower, craft and technician levels and it is at these echelons where the fewest number of efforts appears to have been made. If the EITB philosophy of providing encouragement for the more able young women, in the belief that 'the others will naturally follow', has substance then improvements in women's take-up will eventually percolate down through the system. However, at the present time of economic restraint it is the much larger numbers of girls with average or below average qualifications and ability who are in the most vulnerable position career-wise and it may be that short-term inputs in this region are required to help them consider a wider range of job opportunities and courses.

CHAPTER 4

Commentary on the Courses

As seen in earlier chapters of this report, a considerable amount of evidence has been amassed, through numerous studies, which suggests that a variety of sex differences in attitude, behaviour and attainment is present amongst those studying at different levels within the educational system. It would appear that along with the related problem of sex stereotyping, sex differences are pervasive and have expression in a multitude of ways, both obvious and subtle. They are active in restricting the access of both women and men into occupational areas which have been traditionally the preserve of the other sex. However, much of the previous work which has provided this evidence has concerned itself with differences between young children or teenagers in the school environment; that college-based research which exists is chiefly to be found in America. When the question arises of identifying differences in educational need and performance within the British Further Education Sector, therefore, it becomes necessary to extrapolate findings derived from research conducted elsewhere to a situation where, to a certain extent, the matrix of governing variables is different. This produces a less than satisfactory data-base from which to draw conclusions and suggest developments where some specific need has been identified.

It was not possible in the present study to conduct an exhaustive empirical examination of sex differences in attitude, behaviour and performance which might occur between young women and men pursuing science and technical courses within Further Education. A questionnaire survey of college and polytechnic departments, however, has enabled some idea to be gained of how the problem is being perceived by senior members of these departments, how it makes itself felt and what if any measures are being taken to improve the situation and so encourage the participation of more women in the scientific and technical spheres. The questionnaire (Appendix 1) was designed for completion by Heads of Department because of their curricular and organisational responsibility and the experience which they will almost certainly have gained in the past as lecturers. The survey, which is described in this chapter, is seen as a starting point not an end in itself and, although the results can be set in a wider context by the surveys of research findings and initiatives mentioned elsewhere and by the students' comments in Chapter 5, they require further extension by more detailed research in the future in order to provide a firmer basis for prescription.

4.1 Take-up

4.1.1. Student take-up

Because of the need for up-to-date and reliable information which would be of use in selecting case studies as well as for providing background data, departments were asked to specify which types of full-time, sandwich, block-release and part-time courses they offered and the numbers of women students taking each course (Question 1). Such information is not readily available from government statistics, the most recent of which refer to the situation three years ago; since then it has become recognised that considerable changes have occurred in student take-up. It has been said that in recent years some technical departments have encountered problems in attracting students generally, although it is difficult to find concrete evidence for an overall trend in this direction. It did not appear, for instance, to be the case in the departments visited around the country during the course of this study, although staff may have been reluctant to report falling numbers when there are implications for resource-allocations to their department. Rather, it seemed that departmental provision was in a state of flux in an attempt to meet the needs of, for example, the growing numbers of unemployed and to keep abreast of recent technological advances.

By contrasting the enrolment data collected by the project for the academic session 1979/80, presented in Table 4.1, with that shown for 1977 in Table 1.1, some idea can be gained of the extent to which the pattern of women's enrolment has changed over the last two to three years. It can be seen that, although the two sets of data are not exactly comparable, the most promising upturn in female take-up has occurred in the sciences where women would seem to have increased substantially, as a proportion of the total, within each of the main scientific branches of Physics, Chemistry and Biology. The greatest increase, however, has occurred in the traditionally 'female' disciplines of biologically-related subjects whilst in the medical field the data shows them to be in a majority, although this category comprises nursing and paramedical courses in addition to higher level opportunities. The situation in the technology-based disciplines reveals that, where comparable figures are available, i.e. for the main engineering subjects, women's participation rate has remained static or has shown only a marginal improvement. In none of the main engineering branches do women appear to have reached the 3 per cent level of participation quoted in the Finniston Report of 1980 for undergraduates (using data from several years previous). This indicates, as anticipated, that the problem remains the most acute in the more practically-oriented disciplines at the lower levels where attitudes are said to be the most entrenched against change. It is too early, however, to assess the impact on women's enrolments of the EITB schemes and related publicity-seeking initiatives; the crucial time for seeing any positive outcome of these on overall take-up will be in the next two to three years. It can be seen that there are still microscopic percentages of women on heavy engineering courses at the moment, and also that there are few women who choose to enter the 'craft trades' as plumbers, painters and decorators etc. Women can be expected to have at least some notion of the tasks involved with such occupations and it is reported that several YOPS and Work Experience schemes are now involving young women in these jobs with notable success.

An examination of women's take-up from the point of view of end qualifications and level of the courses (Table 4.2) tends to support the previously-held view that women appear in greatest numbers (although never on a par with men) on traditional, academic courses leading to 'O' and

Table 4.1 Proportion of Women Students Taking Each Type of Course as a Percentage of All Students in Each Subject and Organisation Category

Subject	Full-Time Courses	Sandwich Courses	Block Release Courses	Part-Time Courses	Total
General Science	31·7 (4,835)	15·2 (37)	0·0 (0)	37·6 (3,347)	34·0 (8,219)
Physical Sciences	12·8 (561)	10·3 (97)	5·6 (18)	9·5 (1,178)	10·5 (1,854)
Chemical Sciences	21·1 (602)	24·0 (180)	0·0 (0)	23·0 (1,218)	22·5 (2,000)
Mathematics and Computing	26·3 (1,631)	21·8(1,512)	14·3 (63)	23·0 (1,665)	23·6 (4,871)
Biological Sciences	54·3 (811)	39·1 (645)	0·0 (0)	50·7 (906)	48·7 (2,362)
Medical Sciences	84.6 (927)	33·1 (136)	38·9(1,041)	58·5 (887)	58·6 (2,991)
Earth and Agricultural Sciences	31·4 (191)	27·4 (113)	0·0 (0)	27·1 (181)	28·9 (485)
General Engineering	2·7 (3,437)	7·7 (52)	0·0 (633)	1·8 (3,541)	2·1 (7,663)
Mechanical Engineering	1·3 (634)	0·8 (900)	1·5(1,227)	0·4(13,309)	0·5(16,070)
Production Engineering	4·4 (227)	4·2 (402)	0·0 (0)	1·3 (1,601)	2·2 (2,230)
Heavy Engineering	0.1 (1,281)	0·0 (0)	0·2 (469)	0.6 (1,079)	0·3 (2,829)
Installation and Servicing	0·0 (23)	0·0 (248)	0·2 (624)	0·0 (141)	0·1 (1,036)
Electrical Engineering	2·1 (1,831)	1·1(1,981)	1·9 (898)	0·4 (7,883)	0·9(12,593)
Civil and Construction	1·4 (1,131)	1·7(1,220)	0·3 (680)	2·0 (4,444)	1·7 (7,475)
Manufactured Products Technology	7·6 (66)	8·2 (49)	15·7 (51)	10·2 (668)	10·2 (834)
Surveying	10·9 (533)	4·9 (162)	25·0 (16)	4.5 (819)	7·0 (1,530)
Drafting, Photographer, etc	10·6 (47)	24·2 (33)	0·0 (0)	57·9 (57)	33·6 (137)
Craft Trades	0·4 (276)	0·0 (0)	0·4(1,154)	0·2 (3,519)	0·2 (4,949)
Other	44·8 (797)	39·3 (89)	6·8 (307)	17·0 (989)	26·6 (2,182)
Total	20·3(19,841)	10·7(7,856)	6·7(7,181)	7·7(47,432)	10·9(82,310)

Figures in parentheses refer to the total number of students taking each type of course.

'A' levels, degrees and professional-level qualifications. They are far less common on technician- and particularly craft-level courses where they comprise only 2 per cent of the total. The situation is a little better on technical and craft courses of an introductory nature where women now account for nearly 11 per cent of all students, hinting at the possible efficacy of such provision as a means of access for women into mainstream curricula.

Table 4.2 Proportions of Women Students Taking Each Type of Course as a Percentage of All Students in Each Qualification and Organisation Category

Qualification	Full-Time Courses	Sandwich Courses	Block Release Courses	Part-Time Courses	Total
Professional and Managerial	37·6 (468)	0·0 (28)	19·5 (635)	19·5 (1,556)	22·4 (2,687)
Advanced Technical	14·9 (1,541)	6·3(2,201)	22·4 (665)	9·3 (5,498)	10·4 (9,905)
Technical Supervisory	8·9 (66)	0·0 (0)	0·0 (0)	4·9 (206)	5·7 (262)
Technician	7·6 (3,972)	25·9 (139)	5·9(2,049)	6.0(14,032)	6·4(20,192)
Craft	10·5 (2,846)	1·8 (436)	0·6(3,434)	1·4(18,967)	2·3(25,683)
Technical/Craft Introductory	13·2 (432)	0·0 (52)	18·8 (64)	6·1 (196)	10·9 (744)
Other Technical	0·6 (851)	0·0 (13)	0·0 (0)	25·6 (133)	3·9 (997)
Degree and post-graduate	16·9 (2,217)	13·2(4,987)	0·0 (0)	13·2 (1,891)	14·1 (9,905)
'A' levels	30·0 (4,843)	0·0 (0)	0·0 (0)	35·3 (863)	30·9 (5,206)
'O' levels	46·5 (2,314)	0·0 (0)	0·0 (0)	41·0 (2,283)	43·8 (4,597)
Other Academic	29·8 (506)	0·0 (0)	20·4 (318)	18·1 (579)	22·9 (1,403)
Total	20·3(19,546)	10·7(7,856)	6·9(7,165)	7·7(46,204)	11·0(80,771)

Figures in parentheses refer to the total number of students taking each type of course. Discrepancy in totals between Tables 4.1 and 4.2 arises from a number of respondents failing to state type of qualification within each course category.

The poor showing of women in the block-release and part-time groups within the technical craft categories, relative to full-time courses, is largely due to the small numbers of women employed in the sorts of jobs for which block- and day-release training arrangements would be available. At the heart of the problem at the craft level lies the question of young women finding the necessary opportunities and encouragement to enter apprenticeships and become trainees. By the time that they have had a chance (through such schemes as YOPS or simply through being part of the work force) to find out the attractions of such jobs and gain more confidence, it is already too late agewise. It has been said that employers are reluctant to take on women as apprentices because either they do not perceive them in these roles, they believe that they will not complete the lengthy training or they are afraid of upsetting their existing skilled workers.

The problem can be highlighted by recent figures reported in the 'Department of Employment Gazette' which show that in 1978 there were only 1,310 women in engineering apprenticeships as opposed to 106,110 men. Of all engineering employees only 2·7 per cent of women are in craft grades as compared with 31 per cent of men and only 0·9 per cent of women were classified as 'foremen' in comparison with nearly 5 per cent of men. The proportions of women in the technician categories are confused in the analysis of engineering industries because technical employees are grouped with management, administrative and clerical grades. However, such information is available, albeit on a smaller scale, from a survey of technically-qualified employees in companies within the West Yorkshire area (Barton et al, 1980). Some of the results of this study (Table 4.3) indicate that trained women were to be found in small proportions across the spectrum of qualifications although a significant percentage (28 per cent) were currently undergoing some company-based training and 10 per cent were on day-release courses. The proportional difference in those women receiving internal training as opposed to day-release or off-the-job training may give some credence to the claim that employers do not perceive women employees to be worth such a long-term investment as men (however invalid this may be) and hence are less willing to provide finance for outside education and training. On the other hand, or additionally, it may be the women themselves who, as some psychological research indicates, set their career sights below those of men and are not so demanding of employers for the right to receive extra training and education. It seems, therefore, that the problem of increasing women's take-up of day- and block-release courses in Further Education is a complex one requiring changes in recruitment practices as well as in the attitudes of all concerned. In this there may well be a degree of paradox. If women are to increase in number on day- and block-release courses they need to be taken on initially as employees but as evidence suggests, in order to be taken on, or want to be taken on, in the first place they need to gain the necessary motivation and background skills which, because of inadequacies in their school education, may only be found through further education or employment.

4.1.2 Factors affecting women's enrolments

One of the major open-ended questions on the questionnaire (Question 3) asked Heads of Department to identify the main factors influencing women's take-up of science and technology courses. Many respondents did not perceive the problem to be a matter of one simple cause and effect but preferred to cite several inter-related variables which had a bearing on but did not fully explain the problem. The most commonly-cited factors which were seen to deter women from pursuing science and technical courses were those relating to women's previous schooling – the school curriculum and inadequacies of timetabling and subject choice, teacher attitudes (both female and male) and inadequate careers guidance. As one Head commented, 'all too often careers in technology are regarded as second best by many schools and the more able student is steered away from these' while another considered that the main problem lay in 'the lack of adequate opportunities for girls to study the full range of sciences in schools' and that 'the lack of insistence on mathematics for girls' meant that for many 'the route into a science-based career was barred at the school-leaving age'. Particular mention was made of the lack of facilities for science teaching and attitudes in all-girls' schools but, as mentioned earlier, researches have shown that girls' attitudes tend to be more favourable to science in such schools and in some cases they may receive a much better grounding in these subjects. Women teachers in secondary schools were sometimes accused of 'reinforcing the female-role stereotype' or of 'selling "girls" careers to the children', but the evidence available suggests that neither sex is particularly to blame for this and from the point of view of initiatives to open up non-traditional opportunities for girls in schools and thereafter, women have been at the forefront of attempts to change attitudes and to make developments. While in such statements there may be an element of shifting the blame elsewhere, a few Heads perceived the school influences to be so overwhelming that, as mentioned previously, they took the view that 'there is little we can do at this stage' or that 'Further Education was very much in a second-chance position'. However, as commented by an officer from one of the professional societies, the schools are not entirely to blame because they are constrained in their activities by the 'stranglehold which universities have on the curriculum', through a desire to receive students of a standardised educational background. A more general criticism of teachers was that they were themselves unaware of the jobs available in industry and the day-to-day tasks entailed. Teachers, in addition to the rest of society, tend to retain the 'cloth cap image of industry' claimed the respondents. 'Engineering is still regarded by many as being not fitted for the sons of gentlemen; what chance then for the daughters whilst this attitude prevails' bemoaned one Head while a second considered that the poor public image of engineering was due to the 'media classifying operators, craftsmen, technicians and graduate technologists under one title'. These last two problems have been a focus of attention for the Finniston enquiry. In addition it was felt by some that 'many girls are influenced by their peers not to do

Table 4.3 Qualifications of Employees in 93 Sample Firms

Qualification/Course	Women as a Percentage of Total	Total Number of Employees
Those with HNC/D in Technical Subjects	4·7	1,032
Those with Degree in Technical Subjects	7·9	606
Those with Postgraduate Qualifications in Technical Subjects	1·3	79
Those having Served Apprenticeships	0·3	4,744
Those with Professional Qualifications	2·7	1,296
Those on Internal Technical Courses	28·1	178
Those on Day-Release Technical Courses	10·2	1,419
Those on External Technical Courses	4·8	186

After Barton et al (1980).

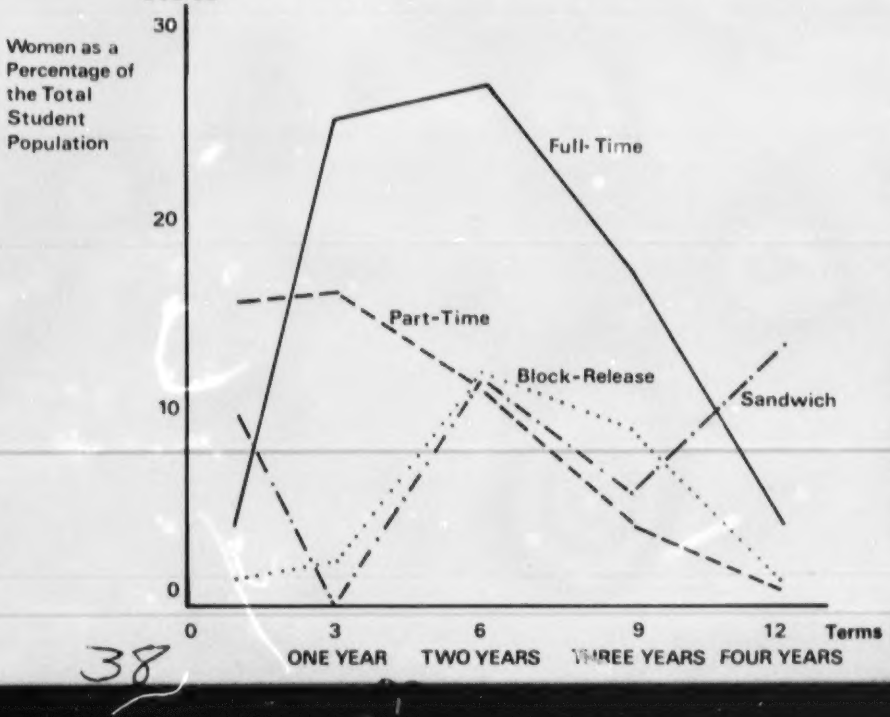
difficult, unfeminine subjects', so that, 'there is a social pressure which is passed on from generation to generation'. Certainly, a number of the comments mentioned women's attitudes to science and technology, claiming that women believed the work to be 'dirty', 'greasy', 'masculine' or simply 'unglamorous'. 'The dark satanic mills, flavoured with the current heavy doses of unemployment, health and safety legislation, must be formidably unattractive to females who by tradition can honourably stay clear' was the pointed comment from one Civil Engineering Head who added, 'would you choose a factory?' Further suggestions for women's lack of motivation towards technical disciplines related to the poor careers guidance and job-related information which women and girls receive. 'There can be only one factor – interest' claimed one respondent who considered that most women were not interested because they were not given sufficient information in order to make an informed judgement: 'Most of our students are school leavers and are much affected by advice given by the Careers Service and school careers staff,' lamented another who regretted that this produced many applications for nursing and secretarial courses but few for engineering.

The blame for women's lack of motivation towards industry and their misconception of the role of technically-qualified employees was not entirely placed within the schools. In both Questions 3 and 24, where respondents were asked to identify the chief difficulties facing women taking science and technology courses, Heads spoke of women's lack of acceptance by peers, employers and other members of the work force. 'They are entering a man's world – male values, male dominated etc., knowing that success is an uphill struggle' stated one Head while another considered that women tended to be seen as 'social misfits by staff and peers and realise that they will find little acceptance in the job market'. As a result of the problem of integrating women into traditionally all-male classes and work-places, several Heads spoke of the lack of confidence and feelings of isolation from which women students suffered and their apprehension about finding a suitable job after the course ended. It was also commented upon that industry and the professions 'had not gone out of their way to attract women', a theory which was partly substantiated by the project's survey of initiatives (Chapter 3). Neither were industrialists, according to the responses, willing 'to invest in women technologists', to utilise their expertise in 'other than mundane, repetitive jobs' or to take a lead in changing shop-floor attitudes and practices. 'Many companies, although not opposed to female apprentices would hesitate to select them in preference to boys, simply because of lack of facilities and the doubts of continued working – why take chances when demand exceeds supply?', was a comment which summed up some of these problems. Surprisingly few Heads spoke of there being any problems of physical capability when the question was raised of women entering the technical fields, and most of these emanated from within the Construction area. Women's and teachers' perceptions of job-related tasks in industry were considered to be a far greater problem.

In terms of adverse factors related to the organisation of science and technology courses within Further Education, several of the Heads mentioned that the length of the courses could be a problem. 'Very few women students are prepared to take up training of a minimum of three years and often five years before being qualified', claimed one such Head with the question of women's possible breaks for family commitments obviously in mind. The take-up data from the questionnaire were collected in such a way that, in most cases, course duration was recorded, thus providing an insight into whether 'length of course' is indeed a deterring factor. These data are presented graphically in Figure 4.1 and show, at a first glance, a considerable variability between different types of course. Some of the fluctuations in the results will undoubtedly have been caused by variable cell sizes (v. Table 4.1), in particular for the 'sandwich' and 'block-release' categories so that too much weight should not be placed on the trends shown for these groups. The two deductions that can be made from Figure 4.1 are that women's enrolments, as a proportion of the total, tend to peak (with one exception) at course lengths of between one to two years and to fall off rapidly thereafter. There would seem, therefore, to be some truth in the suggestion that course-length may be a take-up factor where women are concerned, although this may be partly caused by such issues as employers being unprepared to sponsor women for long courses in addition to women's attitudes.

In Chapters 2 and 3 mention was made of the importance of role-model influences on women's motivations towards non-traditional subjects and careers. Do women tend to enrol in greater numbers in science and technical departments where women academic staff already exist than in those where there are no, or only a small minority of women? Again the questionnaire results from Questions 1 and 2 may provide some clues to this question. Because of the great difference in the overall participation rate of both women staff and students in science and mathematics departments compared with those in engineering, the data were separated into two parts with any 'hybrid' departments such as 'Science and Engineering' being discarded. A correla-

Figure 4.1 Relationship between Women's Take-up and the Length of the Course



tion analysis was then conducted to assess the strength of the relationship between women-students' and women-staffs' participation rates in the two groups of departments. The results of this are shown in Table 4.4 and reveal that in both groups there exists, with a very high degree of probability, a significant correlation between the presence of women academic staff and the enrolment of women students, thus indicating that some role-model influence exists, even in engineering where women as a whole, are in a small minority. It is realised, however, that other governing variables may also be active.

Table 4.4 Relationship Between Proportions of Women Students and Women Academic Staff in Sample Departments

	Science and Mathematics Departments	Engineering and Technology Departments
Correlation Coefficient (r)	0·57	0·56
Overall Proportion of Women Students*	33·7	2·2
Overall Proportion of Women Academic Staff*	23·1	1·4
Number of Pairs Tested	60	104
Significance Level (Z test)	0·001 (very significant)	0·001 (very significant)

*Calculated as a percentage of the total population.

Whilst the survey responses indicate that there was a much greater concern amongst Heads of Department about factors which hindered women's access into science and technology, rather than promoted it, there were a number of comments which identified influences which were helping to change the situation. Three main positive influences were cited:

i. Women's own desire 'to do something out of the ordinary', possibly because of a particularly individualistic streak in their nature, coupled with a 'distaste for traditional women's jobs'.
ii. Good science teaching at school and encouragement from science staff which results in high interest and motivation and provides them with an adequate scientific background.
iii. A relative or friend already within science or technology who can advise and inform them of the attractions of the work and professions.

4.1.3 Improving women's enrolments

Although the responses to Question 3 of the questionnaire revealed that Heads of Department were aware of the various factors which were currently hindering women's entry into their professions, it was disappointing to discover (Question 4) that few (22 per cent) were actively seeking to do anything about it. Of the efforts being made, these mainly involved the formation of links between the department and schools and/or the local careers service with members of the department being prepared to give talks or to arrange link courses. In fact, two Heads contacted the project to provide information on their link courses which they considered to be, for the first time, bringing in sizeable numbers of girls into their departments, if only on an introductory basis. School-college link schemes, however, are said to be on the decline across the country and are being replaced by YOPS programmes and related provision.

A number of respondents believed that good course advertisement had an important role to play in increasing women's take-up. One or two published articles in the local press about the successes of their students or made a special effort through the medium of their departmental literature to stress that the courses and resulting career opportunities were equally suited to young women and men. Only one Head mentioned that the college as a whole had adopted a specific policy of encouraging women to take up technical studies although there was no indication of how successful this had been. A number of responses indicated that, despite determined efforts to talk to girls in schools and to provide attractive course and careers literature, these had not as yet met with much success.

If science and technical departments were not involved in the main with making outreach activities specifically for women, did they offer instead any special introductory or preparatory provision which would be suitable for women or those who had little or no previous experience? The questionnaire results (Question 23) revealed that over a quarter of the sample were currently engaged in such curricular activities in the 1979/80 academic session. Many of the courses mentioned by the 53 departments so involved were of the types outlined in Chapter 3, i.e. pre-technology courses, link courses, City and Guilds Foundation courses, 'O' level packages and short 'appreciation courses' aimed at introducing students to a particular subject which may not have been studied at school as well as a number of bridging courses for adult students.

When asked whether they considered if there were any changes or developments which might be introduced to attract higher numbers of women students into their departments (Question 6), almost 50 per cent provided a positive response. The most frequent suggestions related to improving the course publicity and careers guidance provided by the departments and industry at large. Several requests were made for 'a more open access to local secondary schools, usually only invited to talk to interested male pupils' and mentioned the possibility of utilising the services of women academics and practising scientists and technologists to better effect. A number of comments emphasised the need to change attitudes as well as practices by 'a national advertising campaign', 'pushing the Sex Discrimination Act harder in the local press', 'recruitment drives from local employers' and through 'financial incentives'. Whilst there were fewer comments made which stipulated that some kind of curricular initiatives were necessary, these were not insignificant in number and rather interesting in content. Several suggestions concerned the development of programmes with a high reliance on packaged learning and one or two which sought to broaden the content of vocational courses in order to take further account of students' needs regarding personal and career development. Several proposals mentioned that departments could capitalise upon recent developments in the microelectronics field. 'In many ways work with micro-electronics implies cleanliness and precision coupled with excitement; a definite attraction for women' cited one Head who obviously believed that developments ought to be geared in some way to women's existing attitudes and preferences. Lastly and by contrast, one respondent called for quite drastic changes: 'the local FE system, which makes this college, specialising in engineering, overwhelmingly male-biased, should be redesigned to produce colleges which girls can attend without sticking out like a sore thumb'.

4.2 Students' Performance, Preferences and Attitudes

The questionnaire contained a number of questions which were designed to explore the Heads of Department's views on differences in performance, preference and attitude of male and female students (Questions 9, 10, 11, 14, 15, 16, 17, 18, 19 and 20). In the main it was rather disappointing, although not unexpected, that many should feel that they did not have the necessary experience to make a considered judgement on such issues, as shown by their eagerness in Tables 4.5 to 4.9 to use the 'Don't Know' categories provided with some questions. This was particularly true of respondents from engineering disciplines who, by way of explanation, made statements along the lines of, 'too few women students to judge by' or 'insufficient data – we have only had two women students in twenty years'. These comments are, in themselves, indicative of the size of the problem still existing in the technical fields.

4.2.1 Overall performance

When asked directly whether they considered that women generally did as well as men on science and technology courses (Question 10), a very high percentage (80 per cent) agreed that this was the case and a number expressed the view that the small numbers of women who had studied in their department had been amongst the ablest. 'The few women that have passed through this department in my 30 years of service in it have, without exception, been the best all-round students on their courses', commented one Head, while several concluded, in the words of another respondent that 'generally only the most motivated become involved, so that on average they have a better percentage pass'. However, of the few who considered that this was not so, one or two held the opinion that women students tended to lack the necessary 'stickability'. 'The small numbers of girls who do have technical aptitudes have not the confidence to persevere in this male-dominated field (Electrical Engineering); our best girl technician of recent years left to become a kennel-maid!'. It should also be mentioned that a third view on women's and men's overall attainment was expressed through the comments, and this was that achievement depended upon background, application and ability, and all these seemed independent of sex.

When it came to assessing whether women and men performed equally on a subject for subject basis (Question 11), the Heads tended to fall back on traditional stereotypes. They cited a variety of scientific subjects, especially biology, as being those in which women performed at least as well as, if not better than, men and named the applied subjects as ones in which they tended to perform less well. However, the response in the 'less well' category was much more differentiated than in the other. Of the 54 comments which cited particular subjects in which women's performance did not match that of the men's, 24 mentioned practical or technical subjects and 17 physics or mathematics, with only 11 making other suggestions.

It has been suggested (Murphy, 1978; Kelly, 1981) that women and men may react in different ways to different examination procedures. While women may be at an advantage in written exams which require an essay-type response, men do better in multiple-choice exams or, because of their greater familiarity with tools and equipment, have a higher performance in practical exams. Question 9 of the questionnaire sought, therefore, to discover whether there was perceived to be any validity in this claim amongst those who set and marked examination papers. As the results shown in Table 4.5 reveal, the majority of those questioned did not consider this to be the case, although there was a greater spread of responses with regard to the practical exam situation. Nearly 20 per cent thought that male students might be expected to perform better than females in this instance.

Table 4.5 Views of Heads of Department on Whether or not Women and Men do Equally Well in Different Types of Exams (per cent total)

Type of Exam	Women do Better	Women same as Men	Men do Better	Don't know or Non Response
Written Exams	11	71	3	15
Practical Exams	3	52	19	26
Multiple-Choice Exams	4	73	3	20

N = 195.

4.2.2 Curricular structure and content

Much has been mentioned in Chapter 2 about research findings which have indicated that women and men exhibit different learning preferences. In Question 15 the Heads of Department were confronted with a variety of learning situations for their consideration and the results of this exercise are displayed in Table 4.6. Again these results reveal that, contrary to previous research, the respondents were either reluctant to distinguish any gender-related differences or did not believe that they existed. However, when asked to identify themselves any one type of learning situation in which women did particularly well (Question 17) without comparison with men, a number were prepared to make suggestions of which the following are the most commonly occurring:

Learning Situations in which Women do particularly well

i. Situations, such as presentation of data, in which care and an eye for detail are needed.
ii. Small groups or individual study in which they feel most secure.
iii. Structured learning situations in which a clear framework for study is provided.
iv. Rote learning.

Continuing on the theme of 'learning situation', Table 4.7 shows that of those Heads who held some opinion about grouping by sex, a greater proportion believed that women did make better progress in small groups but considered that there was nothing to be gained by placing female students in all-women classes (Question 16). This latter response is very much in line with their current practices.

In addition to commenting on curricular structure, the Heads were asked in Question 20 to comment on course content by outlining any materials which women particularly welcomed. Although, as before, relatively few felt that they were able to identify any special needs or problems, a number provided some useful contributions which fell into the following two groups:

Course Materials Particularly Welcomed by Women

i. Hand-outs and work sheets, again which provide a certain framework for study.
ii. Materials which relate to people rather than to inanimate objects.

A third line of curriculum-oriented questioning (Question 14) related to whether women exhibited any special study skill problems. While only 16 per cent of the respondents thought that this was the case, it can be seen from the following list of observed difficulties that these correspond quite closely to suggestions made as an outcome of previous studies in this area:

Women's Special Study-Skill Problems

i. Mathematical concepts.
ii. Analytical thought.
iii. Engineering drawing or design which involves the consideration of two and three dimensional space.
iv. Workshop techniques, probably because women lack opportunities to practise such skills.

If Heads of Department did not as a whole consider that women had any particular study problems or required any special curricular provision, were they actively involved with making allowances in general for students' course-related difficulties through tutorial provision or some other spe-

Table 4.6 Views of Heads of Department on Whether Women and Men Prefer to Learn in Different Ways (per cent total)

Learning Situation	Women Prefer	Women same as Men	Men Prefer	Don't Know or Non Response
Theoretical Lectures	5	53	4	38
Demonstrations	5	51	4	40
Group Practicals (structured)	6	45	7	42
Individual Practicals (structured)	9	36	9	46
Group Practicals (unstructured)	1	31	9	59
Individual Practicals (unstructured)	4	30	10	56
Individual Study Outside Classes	18	38	1	43

N = 195.

Table 4.7 Views of Heads of Department on Whether Women Make Better Progress in Small Groups or in All-Women Classes (per cent total)

	Agree	Disagree	Don't Know or Non Response
Small Groups	30	20	50
All-Women Classes	4	37	59

N = 195.

cial teaching medium (Question 13)? The results depicted in Table 4.8 indicate that this was the case, particularly with regard to group tutorials. This high rate of provision may be partly the result of the implementation of TEC regulations which stipulate that group tutorials should form a part of students' weekly course commitment and also encourage the setting-up of remedial classes where necessary. As one person noted, however, there were problems in implementing this policy such as 'time constraints', 'the necessary group activities' and 'limited finance' which tended to reduce such provision 'to a gloss'. In Table 4.8 it can be observed that, of the three types of tutorial help outlined, the fewest number were able to offer students individual tutorials, probably because of the above-mentioned reasons.

Of the various types of 'special help' which were being made available for those exhibiting study-related problems, the most common appeared to be remedial classes in Mathematics and English, sometimes now called 'numeracy or literacy workshops'; extra classes in main subjects, sometimes held in the evenings; extra one-to-one tutorials and individual learning packages which might include library cassettes, slide packs and hand-outs. A number of Heads also mentioned the college and department counselling services as sources of help and in one instance it was claimed that there operated throughout the department 'an early warning system on problems' which depended 'on the quick passage of information to those who can help effectively'. As might be expected, several respondents made the point that all tutors were available to help students experiencing difficulty.

When presented with a question (Question 19) which dealt with attitudes rather than performances, the Heads were more likely to provide a positive response as indicated by Table 4.9. While roughly even numbers of responses agreed/disagreed that women's attitudes to science and technology might be improved if more people-oriented subject matter were introduced into the curriculum, almost twice as many agreed (rather than disagreed) that, if aspects of curricular content were seen to take more account of the social implications of science and technology, then a change in attitude might be effected. Previously in this report it has been noted that other researchers and many of the Heads of Department cited the attitudes of women as being one of the most important factors affecting women's take-up of science and technology courses. When asked directly (Question 18) whether they considered women to have less favourable attitudes in general to science and technology than men, a majority (53 per cent) agreed that this was the case although almost a fifth did not provide an opinion on this matter.

4.2.3 Scientific skills and their improvement

A question on students' visuo-spatial abilities (Question 21a) was included on the questionnaire with some hesitation as it was anticipated that not all respondents would be familiar with the topic. This question, however, provoked some of the most lively commentary of the entire questionnaire. Two propositions were placed before the Heads for their comment: firstly that women tended to have innately lower visuo-spatial skills than men and secondly that any differences between the sexes were the result of a 'practice deficit' in women. Of the 139 who provided some comment, 25 per cent stated that they felt that no overall differences in visuo-spatial ability or scientific skills existed

Table 4.8 Level of Tutorial Provision in the Sample Departments (per cent total)

Total Provision	Percentages of Total Making Provision	Number
Group Tutorials	85	165
Individual Tutorials	58	113
Other Special Help for Those Encountering Study Problems	63	122

N = 195.

Table 4.9 Views of Heads of Department on Whether Women's Attitudes to Science and Technology can be Improved if Greater Use is Made of People-oriented Subject Matter and More Account is Taken of the Social Implications of Science and Technology (per cent total)

	Agree	Disagree	Don't Know or Non Response
Greater Use should be made of People-Oriented Subject Matter	30	27	43
More Account should be Taken of the Social Implications of Science and Technology	42	23	35

N = 195.

between the sexes although, in the words of one Head, 'in some areas women have a practice deficit, in others they have a practice superiority'. It was also mentioned that the student population in Further Education was to some degree self selected so that 'students enrolled are adequately bestowed with these qualities and this may be their reason for a technology career choice'. Several Heads believed that they had firm evidence that women did possess equivalent visuo-spatial ability to men although they did not on the whole deny that practice was important. 'They perform equally well in stereo chemistry and model building' commented one Head of Chemistry, 'their ability is admirable' claimed a Head of Engineering in relation to drawing office and tracers' skills while a third (Head of Chemical Engineering) noted that 'I know few men who can visualise a dress pattern compiled from several others but females can often do this'. Several Heads tended to include manipulative and observational skills within those related to visuo-spatial ability, and where these were mentioned women were perceived to be, if anything, superior. In fact of the comments provided only 2 per cent of the 139 considered that women and men possessed innate ability differences but one Head of Science and Mathematics who had questioned his staff on their feelings had discovered that 'competent women mathematics lecturers in this department identify solid geometry as the branch of mathematics that gives them most difficulty', and added, 'I have met very few women who enjoy chess'. However, even if women do exhibit such weaknesses, socialising influences may be as much contributory factors as innate characteristics.

The vast majority of Heads (61 per cent) commenting upon visuo-spatial and scientific skills clearly saw 'the practice deficit', occasioned by traditional and other socialising influences, as being the root cause of any lack of scientific skills shown by women. There were several explanations proffered as to why this should be. 'Tradition means that the practical tasks performed by girls are domestically rather than technically oriented; boys tend to be interested in Meccano, tinkering with a motor cycle etc., and therefore have a head start on girls in practical classes . . .' was a typical comment. Others spoke of how 'conventional expectations condition women away from such skills' and the 'differing bias in girls' education'. One Head of Engineering described how the chance to practise workshop techniques before college could help women to compete successfully with men: 'A woman on one of our full-time courses had used her father's lathe while still at school. She came to us a competent machinist and the men never caught up.'

If it is indeed true that any lack of scientific skills in women is largely due to a lack of practice – a problem which ought to be open to solution by appropriate strategies – then there are implications for the way science and technology curricula are designed and taught. With this in mind, Heads were asked in Question 21b of the questionnaire to suggest strategies which might increase women's scientific skills and overcome any such problems. 'Slowly build up confidence: so many are frightened off by school science' was one suggestion while a considerable number reinforced their previous comments concerning women's practice deficit by calling for such measures as 'more unstructured practical work', 'a greater amount of time spent on practical, laboratory skills and job placements' or 'more introductory courses to make good the lack of background'. One or two considered that skill training in small groups or on an individual basis might produce worthwhile results. In order to increase visuo-spatial ability directly, 'the field of computer-aided design' was cited as offering one possible solution because of the 'ease with which one can rotate a shape in space using the visual display unit' while another Head considered that 'verbal description and two-dimensional drawings should be read and seen with the three-dimensional product available for comparison; this speeds up an appreciation of the "meaning"'.

In addition to mentioning college-based strategies there were many comments which corresponded to those made in Question 6 where respondents were requested to suggest developments to improve women's enrolments on science and technology courses. These suggestions were concerned with changing attitudes, improving science and technology teaching in schools and ensuring that young girls and boys were encouraged to play with a wide variety of toys. There was considerable emphasis placed in the comments on the need to introduce children, and girls in particular, to science and scientific skills as early as possible. 'A biased encouragement must be given to girls at school from the primary school onwards where there appears to be a dearth of teaching experience in science' was one of several such recommendations which mentioned the importance of science in the primary school situation while another, in the midst of a list of suggestions, spoke of the need to provide 'a technological base for integrating the secondary level curriculum even for the academic streams'. Lastly, one Head of Science made a spirited call for a firmer approach, 'make them (the women) work harder at it without offering any alternative; the Russians have methods for producing female engineers'!

4.3 The Questionnaire – A Summary

While some of the above-mentioned questionnaire results, particularly those in Sections 4.2.1 and 4.2.2, indicate that in certain cases departmental heads were reluctant to make a judgement on possible differences between the needs and performances of female and male students, the impression was gained from the accompanying and often unsolicited comments that the Heads were very much alerted to the wider implications of the Sex Discrimination Act and the current concern with 'equal opportunities'. It may be that some felt that they should not perceive any differences between women and men and so they opted for one of the two 'safe' choices of 'Don't know' or 'Women same as Men'. 'We do not make *any* distinction' or 'we treat all our male and female students exactly the same' were two of the rather defensive comments received to the attitudinal questions. The problems of academics and employers sometimes being unwilling to admit that any problem existed and/or to identify differences in training needs between women and men was mentioned to the project by one or two members of training boards engaged in development programmes for women and also by other women involved with this type of work. It is noteworthy, however, that when the questionnaire recipients were not asked to make direct comparisons between women and men, they appeared more willing to identify learning needs and discuss take-up and skill-related problems in ways which corresponded quite closely to the research findings presented in Chapter 2 and the strategies suggested in Chapter 3. Question design, therefore, may have played some part in eliciting the high 'Don't know' or 'Non Response' rate on some questions. Several of the open-ended questions were intentionally presented so as to be provocative and promote commentary and in this they would appear to have been successful.

The questionnaire results indicate that many Heads of science and technical departments perceive most deficiencies in the system to be outside the colleges and in the schools where they firmly place the blame for the low numbers of women currently following science and technology courses and careers. It is apparent that a considerable number of senior college staff do not realise that they have a role to play in improving the take-up by women of science and technology courses or are at a loss to suggest developments even if they are concerned with the issues involved. It is equally obvious, however, that there are those both inside and outside the colleges who do not share these views and consider, as revealed in Chapters 2 and 3, that there are strategies which departments could adopt, through modifications to their curricular and teaching approaches, rather than the provision of single-sex courses, which would help to improve the situation. As mentioned by several of those interviewed and questioned during this project, such strategies would probably be beneficial to many men as well as women and help to promote overall student enrolments.

CHAPTER 5

The Curriculum, the Teaching and the Students

While research findings in earlier chapters of this report have been presented in a thematic manner, in this chapter, where qualitative case-study data are discussed, a somewhat different approach has been taken. In the first section the overall characteristics of the nine sample departments are compared and contrasted in terms of their geographic location, college situation and general range of provision offered. The departments were chosen using criteria described in Section 1.2. The subsequent sections comprise a number of discrete insights into courses of particular interest which have been selected from the sample departments. Each section describes a single course or a series of related courses offered by one or more departments. In all instances, excepting the case study described in Section 5.9, the course curriculum and organisation are outlined first along with pertinent comments from members of staff and are followed by the views of women students and one or two student case histories.

5.1 The Departments

The departments were chosen from the following locations:

- i. A college situated in an area dominated by heavy industry within the North East of England which is now suffering high levels of unemployment.
- ii. A college which has grown out of a teacher-training establishment and is located in a semi-rural area of Yorkshire.
- iii. A technical college situated in an industrial centre within the West Midlands conurbation.
- iv. A college of higher education residing on the outskirts of a county town in the East Midlands.
- v. A technical college in a town within the Home Counties which specialises in light industry and commerce.
- vi. A college situated in a residential area within the Thames Valley.
- vii. A college in an industrial part of North London which specialises in non-advanced provision.
- viii. A college situated in a county town in Southern England.
- ix. A college of higher education situated in a sizeable port and commercial centre on the South Coast.

Of the case-study departments, several of which brought together combinations of disciplines, five provided mainstream science and mathematics teaching, one domestic science, three general and mechanical engineering, two building and construction and one electrical and electronic engineering. Despite the diversity of provision offered within this group, ranging from basic, introductory courses up to and including degrees, there were shared problems. Most departments were in the lengthy process of changing over from Ordinary and Higher National Certificate and Diploma programmes, and technician-level courses validated by the City and Guilds of London Institute, to those validated by the Technician Education Council. Staff mentioned the great amount of administrative and committee work and endless negotiations involved with this change-over and the additional strain placed on departmental resources because of the more segregated and compartmentalised nature of the courses, the need to make adequate tutorial provision in order to meet TEC requirements and the frequent student assessments which had to be organised. However, almost all welcomed the new developments in some aspects and considered that it would now be possible to design more courses to meet the needs of individual students or specific groups and to take better account of technological advances. One department in the Midlands, which specialised in polymer technology, had both helped to design TEC standard units in this subject and been amongst the earliest to implement the TEC proposals. Five years later the department was at the stage of resubmitting curricula to TEC for fresh approval. With regard to women's interests, the implementation of TEC programmes, which are modular and additive in nature, would appear to be a valuable development.

Another concern of staff in science and technical departments was the growing numbers of unemployed which had to be catered for. Several Heads of Department were currently holding negotiations with the MSC about the provision of short, practically-oriented, introductory courses for these groups. There were some doubts expressed by academic staff, however, as to whether these limited programmes would provide the unemployed with sufficient marketable skills to gain them access into new jobs without having to undergo further education and training. A major problem concerned with providing those receiving state benefits with the opportunity to acquire qualifications, without their losing these allowances, is that the course commitment has to be maintained at below 21 hours per week, well below that of a normal full-time course. One Head was trying to solve the problem of several recently-employed young women and men in his department who were taking day- and block-release courses but who had been made redundant halfway through their training. In most instances these students would need financial help to complete their studies and so acquire the now necessary qualifications to have a good chance of renewed employment. The MSC was being approached for its help in this matter.

It was mentioned by one or two senior staff that the numbers of day-release students had fallen on some courses particularly those, such as motor vehicle engineering, which serviced small local concerns such as garages. In other subject areas the student populations were expanding, especially on full-time courses. The increase in full-time students would ultimately lead, mused one Principal, to the need to expand college careers guidance facilities and other student services. Full-time students who needed to apply for discretionary grants to sustain them through their studies, however, were finding these awards increasingly difficult to come by and one Head felt that the local authority was operating an apparently random system of allocations and this had a disheartening effect upon his students. It was not considered that women were any harder hit by such difficulties than the men. It had been mentioned to the project team in the past that women had difficulty in obtaining TOPS grants for other than traditional secretarial or similar courses. This was not found to be the case, however, and women were, if anything, in greater evidence on TOPS technician courses than others of a similar nature, and spoke in general of the encouragement given them by the local Job Centres to try something more adventurous.

Heads of Department were asked at interview what types of links they had established with local schools and industry. Several departments, it appeared, were involved with link courses for local schools although, as mentioned earlier, they seemed dubious of the outcomes of these ventures on future student enrolments. One concluded that such schemes were useful in helping young people to make a decision even if this was negative and that the previous practice of schools only sending their less able pupils had diminished. It was mentioned in addition that school staff were very suspicious of technical courses and careers, especially in all-girls schools. One Head spoke of the delicate negotiations which had to take place in order to be able to talk to sixth-form girls about, in this instance, electronics. Senior departmental staff were on the whole much more eager to speak about their department's links with local industry than those with the schools. In the applied fields the vast majority of staff had at some stage in their careers worked in industry. These personal links were utilised to good effect in arranging factory visits, work experience and training placements for the students and sometimes even jobs. Personal contacts had been used in one or two instances to break down the reserve of personnel managers about taking on women students. Ensuring that good links were maintained with local industry and commerce was a particular concern of those departments which offered primarily part-time courses, these having been developed in the first place in response to local demand.

Whilst the questionnaire data were collected during the 1979/80 academic session, the departmental visits were conducted during the first term of the 1980/81 year. The Heads of Department at interview, therefore, were asked to describe any changes which had taken place in women's enrolments over the two years. There had, it transpired, been no dramatic improvements. The numbers had remained relatively static and, to the disappointment of those Heads concerned, had on one or two courses actually fallen, indicating instability in the gradual overall trend towards women's higher participation in non-traditional spheres. One or two staff mentioned that women did have a higher drop-out rate on science and technical courses than men. The only woman head of department interviewed during the study, who was on the whole reluctant to concede that women had any special study needs or problems, commented on the subject of student drop-out that 'women tend to throw their opportunities away'. They would, she maintained, take a demanding course of study and then drop out just before exams because of marriage or some other domestic commitment. When asked under what circumstances men tended to leave the courses before their completion she considered that there were no comparable circumstances. The socialising process was blamed for the problem. One of the student interviewees, who was in the final stages of completing a series of electronic engineering and radio operators' courses, noted that she had started out upon her training several years previously as one of several young women who had been keen to train for an engineering career. She was the only one who had seen the training through to its completion, the others had dropped out one by one for a variety of reasons, although she concluded that it was the 'theory', rather than home or family commitments, which had ultimately led to their departure. It was noted during the project's review of the literature that scarcely any research has been carried out into the possible reasons for women dropping out from courses which might be designated as non-traditional. From discussions with staff and students it does not appear that the problem, which is of unknown dimensions, can be attributable simply to one cause and some further study might produce some interesting findings.

5.2 Introductory Science

5.2.1 The course

The department which was placing the greatest emphasis on the provision of introductory science courses, had for several years been considering a broad-based foundation course because of the numbers of students which had been turned away from the department as not having reached the required educational standard for one-year science 'O' levels or technician-level courses. The department ran the City and Guilds Foundation course in Engineering (CGLI 686) which is geared, on three levels, to operator, lower craft and technician grades and is suitable for school leavers. In the past there had been a good intake into the course with good results, but increasingly, the staff considered that the students entering at the lowest level had been of a lower calibre, multi-racial and with poor motivation. For many the only reason for coming to college was fear of unemployment. It was decided, therefore, that there was a need to design a new, full-time course which would provide access for the 16 to 19 age group into college science and technology curricula, and also improve their literacy and numeracy skills. The introductory science course which had resulted was being geared to the City and Guilds Science Laboratory Assistants (CGLI 755) syllabus (which was also offered by another department but not advertised specifically as an introductory course) and to RSA* qualifications in English and mathematics. Examinations in these could be taken at intervals during the year according to students' development. Students gained entry to the course by sitting a departmentally-devised test; if they performed well in this they might gain direct entry into 'O' level classes. The course has the following weekly curriculum:

6 hours English
5 hours mathematics
5 hours physics
5 hours chemistry
4 hours biology
3 hours environmental studies
2 hours liberal studies

It was considered that the students, because of their study-related problems, should be taught in manageable-sized groups. The 23 students enrolled for 1980/81, therefore, were separated into two teaching and counselling groups after a short, induction period. It was decided that this split would not be made on the grounds of ability as previous experience had shown that this led to bad feeling amongst the students. The course does not comprise any formal lecturing as such; students learn through practically-oriented work. When the course tutor was asked which were the chief learning problems exhibited by students at this level, it was mentioned that (a) their written work tended to indicate mediocre levels of literacy, (b) their deductive processes were not well developed and (c) they had poor observational skills.

5.2.2 The students

5.2.2.1 educational background

Of the 23 students taking the course there were three young women, who were considered by staff to be slightly better than average, especially in biology. Physics was said to be their worst subject and this was substantiated by comments of two of the women who were available for interview. The educational backgrounds of the women were similar in that they had achieved CSE grades 3 or 4 in, perhaps, English, one other arts subject, mathematics and one or two sciences, but had rarely attained a pass mark at 'O' level standard. Their need of some type of introductory provision was also confirmed from a glance at the college entrance-test results which revealed an overall weakness in the sciences and only moderate levels of literacy. Nevertheless, one woman expressed some dismay at having to spend a year taking what she perceived to be an extra and unnecessary course. She had wished to retake, immediately, the 'O' levels which she had completely failed while at school and claimed that she was already familiar with the course work and, therefore, 'bored'. The course tutor mentioned that this impatient approach to study was common amongst the younger students who had recently left school. Similar observations were made of student groups in other departments during the research programme.

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* RSA – Royal Society of Arts.

5.2.2.2 career aspirations

When asked about their future plans the two women interviewed expressed almost identical opinions. They spoke of not wishing to pursue careers of a secretarial or clerical nature and mentioned laboratory work as a possible career goal although neither was fully committed to this end. Of all occupations mentioned to the project by those women not already in employment, the response of 'laboratory work', without any other differentiating comment, was by far the most common. This would indicate that, even for young women who have been motivated towards non-traditional courses of study, there can remain a lack of understanding of the spectrum of opportunities available to them within such broad categories as 'laboratory work'. Such a finding places a further question mark against the careers guidance which many receive. Without adequate assistance in this area, unrealistic choices may be made, perhaps because of negative reasons than out of interest in the occupation itself and informed judgements.

5.2.3 Introductory science courses run by other sample departments

Three other departments were offering one-year full-time introductory courses in science and technology; in one case, however, the course entitled 'Foundation Course in Science', whilst described in some detail in the prospectus, was not mentioned either on the questionnaire or at interview. This programme which had been designed jointly by the college and the City and Guilds of London Institute (CGLI 687) was aimed at providing 'an introduction to careers and jobs in science-based industries' and 'experience in a range of employment activities so that the student can explore his or her interests and abilities before making a choice of career'. Possible careers mentioned were, laboratory work, quality control and chemical process work. The syllabus included:

Science skills and procedures

Scientific principles

Industrial and environmental studies

Communication, cultural and recreational studies

Careers education

The second full-time programme was an example of a 'pre-technology' course and was being run jointly by the science and engineering departments of the college concerned. It was designed primarily to lead into OND or Ordinary level TEC courses and to compensate for students' lack of background. The subjects studied comprised: mathematics, engineering drawing, materials and process, English language, general studies and workshop skills. One young woman was interviewed who had been the first female to take this course and she commented that it had helped her immensely, especially on the practical side. She had experienced difficulty whilst at school in convincing the teachers to allow her to join an engineering drawing class. It had been stated that she would be taking the place away from a boy! The pre-technology course, she considered, had helped to compensate for her lack of skills and she was now confident that she could succeed in engineering. The Head of Engineering, who was sympathetic to the concept of encouraging women into technology, mentioned that the course now had several women taking it and that this was a favourable indication for the future. The third full-time course was very similar to the last described above and was termed 'pre-professional level'. It comprised a programme of TEC level 1 units and enabled students to sit 'O' level examinations in some of the subjects.

Of the other initiatives in this area, one college ran a 'Pre-TOPS' course for students to improve their literacy and numeracy where necessary, whilst another ran two special evening courses. The first course ran over one year with basic biology being taught in the first term, physics in the second and chemistry in the last. Students could enrol for all or just one of these options. The second course placed a greater emphasis on practical laboratory work and the handling of experimental data than the first and was designed as a Pre-Open University course or for those who wished to go on to more advanced study later. In addition two other departments offered 'O' and 'A' level revision courses for those who were not able to study the full range of science subjects whilst at school or had failed to achieve the necessary grades for entering higher education. On one course it was stated that approximately a quarter of the students were women and that of those taking the 'A' level programme, roughly 50 per cent succeeded in gaining entry into the degree (or equivalent-level) course of their choice.

5.3 EITB First Year Off-the-Job Training

5.3.1 The courses

It was apparent from the questionnaire responses that very few women were embarking upon skill-based training in the main engineering branches. Of the two engineering departments in the case-study sample who were running, for example, the EITB Off-the-Job Training Scheme, the female participation rate was 1 out of 150 in one case and 4 out of approximately 160 in the other. The EITB programme has been devised to provide comprehensive training and integrated education for first year apprentices and other trainees who might proceed to technician level jobs in the mechanical, electrical, electronic and fabrication industries. In the example of such a scheme described below, two patterns of training were available. There was a 'skills-based' programme, intended for those working at craft level, which involved an initial 11-week induction period into general workshop practice (which would be useful for girls without previous training), followed by a 23-week basic-skills training period and 12 weeks in which trainees specialise in one specific set of skills. The EITB end-of-course certificate has an endorsement relating to the skill in which the student has specialised. The other training programme available for those of potential technician or technician engineer capacity, comprised a shorter induction and basic-skill training period (23 weeks in all), thus allowing an extended period for project-based training. During this time the students work in small groups and plan, design, draw, manufacture, test and report upon the project. The Head of this department mentioned that the projects were usually of a very high standard and the end-products placed on show at an open day at the end of the year. After this first year students usually return to college to continue their training on a day-release basis.

5.3.2 The students

Four young women, who were either engaged upon an EITB Off-the-Job training scheme or had completed their first year and were studying at college on day-release, were interviewed as a group from the second course mentioned in Section 5.3.1. It was interesting to hear from this group of students that they did consider that they had received ample opportunity to take science while at school and had been encouraged to consider a non-traditional occupation thereafter. Two of the girls, from the same school, had been able to take metal-work while at school and a third, engineering drawing and this favourable experience in practical skills had, it was agreed, had a decisive influence on their subsequent career choice. The two young women mentioned that they had been amongst the first girls to choose metal-work in their school and that the metal-work class was now comprised of almost 50 per cent of girls. There was general agreement that they were enjoying their training, all hoped to complete it and to have careers within engineering, two on the electrical side and two as mechanics. One of those who wished to be a mechanic said that she had been used to 'tinkering' with her father's car whilst at school and that this had led to her initial interest in such work.

In this case study the women students clearly appear to represent the outcome of a series of favourable motivating influences, not only at school but in the home and also at work where they felt themselves to be valued employees and not under any particular stress because they were fulfilling non-traditional roles. The fact that they were progressing through their training in pairs and did not feel isolated, had obviously promoted their progress and confidence. Such confidence was often lacking in other women who were studying and training alone and had found it a struggle to follow the career of their choice, often against considerable opposition.

5.4 Laboratory Technician Courses

5.4.1 TEC science

5.4.1.1 the courses

All five of the sample departments providing mainstream science programmes offered technician courses in laboratory skills validated by TEC and usually available to students on both a full-time or a part-time basis. Individual departments are able, by amalgamating standard TEC units with ones written in the department into a structure of core subjects and options, to construct courses which can meet local employment needs and characteristics. For instance in a college in an area with a concentration of large chemical, petro-chemical and iron and steel concerns the following units had been brought together in order to provide a course curriculum (full-time) which would form a sound basis for entry at technician level into the various types of employment available locally. The resulting course included:

Core Units

- Chemistry, physics, mathematics
- General and communication studies

Optional Units

- Laboratory procedures
- Analytical chemistry
- Structure and properties of metals
- Metallurgical production technology
- Metallurgical process technology
- Biology, physiology, biochemistry

5.4.1.2 the students

Four women students were interviewed who were attending a laboratory technician course at the abovementioned college. On this course women accounted for approximately a quarter of the total student body. All four considered that they did not receive sufficient encouragement while at school and only one possessed a good school-science background. They felt that they were coping as well as the men with the classes but in the early stages of the course had been at a disadvantage in practical work; this problem they had eventually overcome. Of the four, two worked as chemical technicians for a large petrochemical company, one for the local water authority as a microbiological technician and the last for another petrol-chemical company as a chemical analyst. All were in the 16-19 age range. One of the main motivations for their choosing their present employment had been the realisation that they would earn good wages, better than most of their friends and have more varied careers.

5.4.2 School-laboratory skills

5.4.2.1 the course

By comparison with the above example a TEC certificate programme for school laboratory technicians might include such topics as 'Safety and Laboratory Practice'; 'Workshop Processes and Materials'; 'Audio-Visual Aids and Display Work' and 'Laboratory Organisation' in addition to more theoretical units in the physical and human sciences. One of the departments offering such a course on a part-time basis timetabled the classes between the hours of 9.00 a.m. and 4.00 p.m. in order to attract married women students. The course was felt to be suitable for older students who might like to fit in school laboratory work with other commitments, although it was recognised that vacancies for such employment were currently at a premium.

5.4.2.2 the students

In the 1980/81 session the course attracted 20 students of whom 18 were women, indicating that the staff had been successful in meeting one of their objectives. With a high intake of mature students, however, it was considered that care had to be taken over the teaching methods employed. For instance confidence was a problem amongst the students at the start of the course, as many had out-of-date qualifications, and topics had to be introduced one by one, starting with those with which the majority of students felt at ease. The Head of Department concluded that such courses required the services of experienced staff who had a certain sympathy with students who exhibited low confidence levels. Unfortunately the department was not visited at a time when this group of students were in attendance and could speak of their experiences.

5.4.3 TOPS laboratory technician courses

5.4.3.1 the course

TOPS technician courses have been developed to provide the post-19 age group with intensive, practically-oriented training opportunities which also provide a certain amount of theoretical knowledge. A City and Guilds or TEC award is usually made upon students' successful completion of the course. The two courses visited during the study were both full-time, of one-year's duration and attracted a fair proportion of women (between one quarter and one third of the total).

The course run by a college in the North East of England was, according to one tutor, helping women to break new ground. Until the Sex Discrimination Act the local petro-chemical concerns had not taken on women as technicians because of traditions relating to shift working. Since that date the position has gradually changed and employers have been surprised to find that there have been no real problems. However, the college principal remarked that such tasks as outside plant inspection-work, which had to be conducted at night, were still closed areas for women and he thought that this was likely to be the case for a considerable space of time. The syllabus of the course had been written so that students could keep their options open and become either school or college laboratory technicians or work in industry. This he felt was a particularly useful development for women. The course had in the past resulted in a good student success rate and up until the present year all those completing the training programme had, over a period of several months, found jobs. The employment situation would be more difficult in coming years it was concluded.

5.4.3.2 the students

Discussions were held with three of the four women currently engaged upon the North of England course and reveal a mixture of previous backgrounds and experiences. The student group was made up of approximately twenty students in all.

5.4.3.2.1 backgrounds

Two students were in their early thirties and both were married with teenage children. In other ways, however, their backgrounds were different. While one woman had obtained science 'O' levels some 15 years ago, had worked in a medical laboratory and was now looking for interesting scientific work when her children would be grown up, the second had little previous experience in science either at school or work. She considered that she was taking something of a gamble upon being able to succeed in an entirely new occupation which required learning new skills but felt that in the present employment situation she had nothing to lose. This same feeling was expressed by the third woman student who was younger than the other two and had been engaged in clerical work for several years but had come to the conclusion that there were no prospects for her in this type of work. All three women interviewed had arrived at college through having contacted their local Job Centre after having heard of the course through friends or the local paper.

5.4.3.2.2 curricular issues

The three students were in agreement that the course was highly enjoyable, particularly the practical aspects, and spoke of the help and understanding afforded them by the lecturers. Of the two students who had a poor scientific background, the older one of the two was encountering some difficulty with the syllabus, particularly chemistry. On the other hand the younger woman was coping well and was said by both the lecturer and her male companion to have a natural ability and grasp of the practical techniques.

When questioned in more depth about the course curriculum the students mentioned that the main area of difficulty had been the organic chemistry element. The course had, unfortunately, begun with organic chemistry which involved a great deal of rote learning, and they considered that it would have been better if it had begun with easier material. In contrast with some other women's comments, the physics classes were found to be the most interesting and understandable parts of the curriculum. The reasons for this were that the teaching was excellent and the lecturer had applied the concepts to examples with which the students were familiar. For similar reasons the mathematics lessons in the course were also found to be very enjoyable.

5.4.3.2.3 career aspirations

All students were slightly worried about their immediate job prospects because the employment situation in the area was not good. Although they spoke of the possibility of finding work in either school or college laboratories, they were aware that better opportunities probably lay in industrial situations. It was hoped that the visits to local companies, which were to be arranged for the following term, would help to clarify the types of opportunity open to them and to overcome their present indecision. However, these women students were noticeably more confident and purposeful about their futures than those younger women who were visited at the second department (in the Midlands) which was running a TOPS technician course. The students on this second course were not only less willing to speak of their experiences (which in terms of school science were generally unfavourable), but were unsure about their career plans. They tended to speak of having tried traditionally-female jobs and found them unfulfilling and so were in the process of exploring the alternatives. It was clear from the comments of students on both TOPS courses that the women were using these programmes not only to gain new skills but also in their search for practical careers guidance and help in decision-making, which one or two mentioned was hard to find elsewhere. This leads on to the question of how much guidance and counselling should actually be built into introductory science and technology curricula and whether such students are able to make full use of student counselling services available in many colleges.

5.4.4 Chemical and Metallurgical Technicians Course for the Unemployed

The local office of the MSC has devised a new combined chemical and metallurgical course with the help of the department which specialises in metallurgical studies. The course which began for the first time in Autumn 1980 was designed to run for 21 weeks on a full-time basis. It provided students each week with two days each of chemical laboratory training and basic metallurgy and one of first aid, life and social skills. Again this course was designed with the aim of fitting students for dual entry into two different types of laboratory work. The course tutor was unsure about the worth of this new course as he considered that the students would be ill-prepared to meet employers' needs and felt that the programme should be more sustained and include more theory. At present the students would not receive an end of course certificate. It was hoped that with the consent of the MSC a follow-up programme of TEC level 1 and 2 units could be devised (without over-stepping the 21 hour per week attendance limit) in order to increase the students' viability in the job market. While it was not possible to speak to the women students who were fully occupied, the tutor considered that they were able students and above-average in a number of aspects of metallurgy study, especially those in which manipulative skills had to be employed. One young woman on the course was said to be outstanding. Through his contacts with the personnel department of a local iron and steel company it had been found that, despite the recession, three or four new technicians were required for their research department. The personnel officer concerned had already examined the work and records of several students and was likely to offer two of them, including the very talented woman, a job.

5.5 Marine Electronics and Related Courses

It is only to be expected that a college situated in one of the country's major ports would make some curricular provision which related to seafaring and communications but it was a little surprising, given the low participation rate of women in the applied fields, to find that women were taking advantage of these courses and were, just as their male peers, 'hoping to go to sea'. The department was visited at the time of the announcement that the first woman had gained her full master's certificate and been given the responsibility of a vessel within the merchant navy. Both staff and students were delighted with this development and felt that the publicity surrounding the event would encourage other women to follow. Along the South Coast the questionnaire results revealed that women were beginning to make their way into another male-dominated preserve, i.e. shipbuilding. Several were in the process of training as shipbuilding technicians. Unfortunately the department could not accommodate a visit from the project until after its completion.

5.5.1 Marine electronics

The department is one of the main centres in the country for marine electronics courses and the training of radio officers for the merchant navy. The marine electronics integrated course is unique in that it not only prepares students for employment as marine radio officers but also for radio work on shore-based establishments. The BBC and IBA, for instance, are interested in graduates from the course and at the moment there are better job opportunities on land than at sea. The course lasts for three years and leads ultimately to Higher TEC as well as professional qualifications. Students are normally required to have gained 'O' levels (or Grade 1 CSEs) in English and mathematics although science qualifications are an added recommendation. Where students do not meet these standards they can gain admission by sitting a college entry test, a factor which helps girl entrants who may not have had the same opportunity as boys to study mathematics and science at school. The course combines theoretical studies with extensive practical training in communication procedures and in the operation and maintenance of electronic equipment. In addition the students are required to take part in boat handling, boat drill, swimming and life-saving classes and visits to ships and shore-based establishments are arranged at intervals. The Head of Department mentioned that the course was attracting a number of women students because they perceived it to be a 'glamorous' option.

5.5.2 The students

There were five women in all following the integrated course in marine electronics during the 1980/81 session; in the previous year 10 out of 100 students had been women. Considerable variability from year to year in the proportion of students who were women was a feature of several of the science and technology courses visited and this indicates that enrolment figures from a number of consecutive years need to be examined before any definite trend in women's participation rates can be identified with confidence.

5.5.2.1 backgrounds

Four students were interviewed who were in either Year One or Year Two of the integrated course and all mentioned the difficulties and resistance which had been encountered in their attempts to pursue courses in a technological field. All had recently left school. The case history of the only woman in the first year of the course was particularly interesting. Her family was deeply involved in the electronics industry, including her father, brothers as well as other relatives. Since the start of her teens she had wanted to do nothing else, and, although she was able to study sufficient science while at school, the teachers and careers officer had been very unhelpful and strongly advised her not to contemplate such a career. Undeterred, she had joined electronics clubs to find out at first hand what the work in the electronics field might involve and, when the appropriate time arrived, had written off to colleges to find out the range of courses available. She had decided upon the present course because she liked the idea of being a radio operator on a ship, despite the fact that this entailed living away from her home in Kent while she trained. It is notable that in this, as in several other cases, family influences had proved to be stronger than negative school attitudes.

In addition to the four young women interviewed who were undertaking the integrated course, discussions were held with two mature students on other electronics courses. Both had interesting histories to relate. The first woman was taking a TEC Higher Certificate course in communications and had progressed through a series of training opportunities, starting off with City and Guilds courses, Post Office certificate and marine operators' courses. Her motivation to enter the electronics field had arisen from her attendance at an open day held by one of the large electronics companies in the area at a time when she was feeling frustrated by the limited job opportunities open to her in traditional occupations. She was presently employed by Marconi Space and Defence Systems as a 'micro-electronics quality assurance technician' and was on day-release to college for career development reasons.

The second woman was in the process of gaining an HND in electrical and electronic engineering. She was in her late twenties and had dropped out from university some years earlier. The last few years had been spent working on and skippering hired yachts in the Caribbean, during which time she had become interested in electronics and navigation. She had come to the conclusion that she was better at fault-finding than many of her male colleagues and this had given her the confidence to apply to the college on her return to England. She had originally applied to do an ordinary level diploma but it had been decided that she had the necessary skills to gain direct entry into the HND course.

5.5.2.2 curricula and career aspirations

Of the four young women taking the integrated marine electronics course, three wished to become radio officers in the Merchant Navy and one to work in a similar capacity on shore. All believed that they would find employment upon graduating from the course and had not made any secondary plans. As mentioned previously the Marconi employee was attending college for career-development reasons, whilst the woman on the HND course was still undecided as to her future intentions and thought that a broad-based electronics course would lead to a wide range of job prospects and provide her with flexibility.

As to the courses themselves, all six students interviewed expressed in some way a sense of isolation occasioned by the pursuit of non-traditional careers. The young women on the marine electronics course felt that it had taken a while to settle into the course during the first year, generally because they had inadequate science and skills-based backgrounds relative to their male peers. It was considered by the second year students that nearly a year had passed before they had really felt 'at home'. The student in the first year had been surprised to find herself the only woman in her year group and had found it difficult at first to accept this fact. The three second-year women had, however, introduced themselves and helped her to settle in. All students interviewed mentioned that the staff had been very willing to help with problems as they arose. Academically few problems had been encountered and in such skills as telegraphy, and fine manipulative skills, the women were said to be on average better than the men. The hardest part of the marine electronics courses at least had been the stringent life-saving and swimming classes which all students were called upon to attend.

Clearly this case study presents an optimistic picture of women being positively motivated towards a non-traditional career choice, enjoying their training in a supportive and friendly atmosphere and being confident that they will succeed thereafter.

5.6 Technician Courses in Polymer Technology

5.6.1 The courses

The rubber and plastics industry in the Midlands has been built up over the last twenty years and a college situated in this area has been offering courses to meet the training requirements of local employers since the mid 1960s. The department was one of the first to implement the TEC proposals and since 1976 has developed several new curricula at technician level. The longest running TEC programme is a two-year scheme run in conjunction with the Rubber and Plastics Processing ITB. Students attend college full-time for the first year and continue their training by day- or block-release in the second. A TEC certificate course offered solely for day-release students is also available. Since 1978 a Higher TEC programme has been in operation which can be taken on a two-year, part-time basis. For those who are well-advanced in their training, the professional qualifications of the Rubber and Plastics Institute can be taken with specialist options in either rubber or plastic technology. The larger number of students is still interested in programmes with a bias in rubber-related topics.

The entry qualifications required are above average for most TEC programmes as the staff consider that the courses are demanding. The GCE 'O' level qualifications stipulated are in mathematics, English language and at least one other science. The Head feels that those having CSE grades below Grade 2 will not complete the course. There has been a gradual improvement in the numbers of women students coming into the department particularly over the last two years. It was considered that the 'A' level system was partly to blame for the slow pace of this change because it steered pupils, particularly girls, in only one direction. The department had several women members of staff who were mostly part-timers and deployed in the biology area. There had never been a single female applicant for a technology post in the Head of Department's experience. As few women to date had entered industry, and staff were expected to have acquired some industrial experience, it was not difficult to perceive why this should be. When asked if there were any curriculum developments planned for the future the Head mentioned that these lay in the area of provision for the unemployed and a short, MSC-sponsored skills-based course was to be run in the coming year. Unemployment had not been a factor in the area until very recently.

5.6.2 The students

Eight women students taking a variety of TEC certificate or graduateship programmes in polymer technology were available for interview although there were others, not in college on the day of the visit, who were embarked upon such courses. Statistics from the previous session revealed that there had been two women (out of a total of 32 students) on the full-time course and nine (out of a total of 134 students) on the various part-time options. In this department at least, therefore, women's enrolments would appear to have been maintained.

5.6.2.1 backgrounds

All students interviewed were already in employment and ranged from those who had only recently left school and found a job to those mature students who had been in technical work for several years and were taking professional qualifications. Almost all were working in the laboratories of large rubber and tyre companies with only two involved with plastics technology.

In several cases the women had arrived in their present jobs by indirect means, not having considered such career opportunities while they were at school. Two students had originally begun work with their employers in different capacities, one as a clerical assistant, the other in the chemical laboratory, but had been moved into polymer technology as internal vacancies had arisen. Both claimed that they had welcomed this move and nearly all students interviewed considered that their jobs were more interesting than those available in ordinary science laboratories. This was despite the fact that much of the work was dirty, and involved the use of complicated and often noisy machinery. Only one of the women had been directly influenced by a near relative to follow such a career although one or two of the others said that they were aware, because of contacts in the industry, of the type of work involved. Another had found her present job through participation in a work experience scheme.

5.6.2.2 curricula and career aspirations

As almost all the students interviewed were said to be of above-average ability, there were few comments concerning curriculum-related difficulties. The only exception to this was a mature student who felt that the integrated science course, which she had taken while at school some years previously, had not provided her with a strong enough background to cope easily with the chemical aspects of the course. This same student said that she had been surprised with the amount of workshop practice that was incorporated into the ordinary-level certificate programme which she was following but had come to enjoy such work. When asked about their future intentions, the younger students said that they hoped to continue their training either to higher TEC or graduateship levels and expected to continue in polymer technology for the foreseeable future. Two students who were taking their professional qualifications mentioned that when they first began employment they were the only women holding technical positions in their respective companies and they had to cope with considerable shop-floor resistance. This situation was now changing and other women had gradually been employed in the laboratories. Both hoped to be able to progress into supervisory or managerial posts, although neither knew of any women holding such a position at the present time.

The students in this case-study, therefore, had quite clear vocational goals and were, for the most part, settled in their occupations and could foresee the way ahead in their careers, barring the threat of unemployment which was beginning to affect the area. Having seen the tasks involved in fulfilling the role of polymer technology technician, the work does not appear to be one which might immediately appeal to many women, but the students interviewed contradicted this opinion. This occupation, however, is just one of the varied types of work which women might seek out under the general heading of 'laboratory technician' but which, as yet, remains beyond the knowledge of many.

5.7 Technician Courses in Building and Construction

5.7.1 The courses

The two departments visited offered a range of ordinary and higher certificate and diploma courses in construction, building and civil engineering. Technician certificate and diploma courses in building studies were quite popular options with the women. These programmes were intended for those undergoing training as Architectural, Building, Estimating or Quantity surveying technicians and the minimum entry qualifications required for entry were three Grade 3 CSE passes. The curriculum of such programmes contains a combination of TEC level 1, 2 and 3 units which, depending on the mix of units taken, can lead either to a TEC certificate or to a diploma. The range of units offered by one of the departments comprised:

Mathematics
Physical science
Organisation and procedures
Construction technology
Site surveying and levelling
Science and materials
Elementary accounting procedures
Design procedures
Measurement
General and communication studies

Several of these subjects were available at more than one level.

It was noted earlier in the report that 'Construction' was the subject area from which most comments arose which adhered to the view that women had no place in technology, would be at a grave disadvantage physically or would not be accepted as part of the labour force. These feelings were amplified by one senior lecturer in this discipline who considered quite vehemently that, while women might perform well in the drawing office or surveying situation, they did not have the capacity to work on construction sites or as bricklayers. He claimed that he had watched women working alongside men at such work and they never became equally involved in the physical tasks as the men and often preferred to watch. Of course there may be another factor which had influenced this observed behaviour. The men might not, out of tradition, feel entirely willing to allow their female peers to become involved in those tasks which they perceived to be physically demanding and so, openly or subtly, encouraged them to play a different role. The Head of Department concerned, took a more open-minded position on this question, although he conceded that Construction was still a very difficult area for those women who wished to gain entry. Staff members in the other department running construction courses, however, welcomed the participation of women in their discipline. Their more favourable attitudes may have resulted from the fact that they possessed greater experience of women construction students.

5.7.2 The students

In the second department, which, in fact, possessed the highest number of women students of all such departments which responded to the questionnaire survey, there had been 16 women enrolled upon courses during the 1979/80 session. Whilst this participation rate was still low as the female students were greatly outnumbered by the men, there were sufficient numbers of them to form a self-supporting group. Surprisingly, given the positive relationship which was revealed between proportions of women staff and students by the questionnaire data, there was only one part-time woman member of staff in this department.

5.7.2.1 backgrounds

Six students were available for interview when the department was visited. Four of these were under 19 years of age. One of the common threads through the comments was the fact that nearly all the women had been influenced in their career choice by a close male relative. Their motivation towards a career in building and construction appeared to have arisen in their mid teens when, with the help of this relative, they had explored the possibility of careers in construction and started to make the necessary arrangements. Given this situation, it was interesting to find from their backgrounds that three of the six women had only taken an integrated science course or science up to the third year while at school, although two stated that they had wanted to study more science but that no opportunity was available. Only one woman had been able to take craft subjects while at school and she had achieved a CSE, Grade 1 pass mark in both metal work and technical drawing.

5.7.2.2 curricula and career aspirations

Almost all students interviewed on construction and building courses stated that they particularly liked drawing office work, perhaps because this involved tasks with which they felt most familiar and at ease. With regard to the course curricula, the 'technology' units in the courses were also popular and, with further discussion, it was revealed that these dealt with the theoretical aspects of the subject. Whilst not disliking the practical aspects of the courses the women reported that it had taken them some time to become familiar with the skills involved and to gain a comparable confidence to their male peers. One or two noted that there had been settling in problems to cope with at the start of the courses but that these had been overcome. Again all expressed a desire to pursue careers in their chosen disciplines and one hoped to be able to work for her father who had his own building business.

5.8 Combined Studies Degree Course in Science

5.8.1 The course

The college is one of a growing number of polytechnics and colleges of higher education around the country which have developed over recent years modular degree courses on patterns similar to those in existence within American colleges and universities. The concepts of introducing sufficient flexibility into the system in order to cater for individual learning needs and to produce more qualified people who have a breadth of knowledge rather than a high degree of specialisation in a narrow range of skills and theory, are highly attractive to many educationalists. The course operating in the present college enables successful students to achieve an honours degree in either the arts or the sciences, depending on the mix of options taken, over a period of three years. While it is possible to specialise in one or two particular subject options, in which students may already have gained a certain proficiency, it is also possible and indeed encouraged to enhance a very moderate knowledge up to a standard which is valuable for employment purposes or provides suitable back-up to their main area of specialisation. The course, therefore, is thought to be very useful for intending teachers and some of the 30 or so options available have an educational emphasis.

Although it is recognised that modular courses are of great value to women who may suffer interruptions in their training and careers, the main reason for a visit to the college was to see at first hand some of the teaching and the students on one particular degree course option entitled 'Matter, Energy and Chemical Change'. This course unit had been identified earlier on the questionnaire and in an article in the educational press (George, 1980) as attracting a relatively high proportion of women students. The course was being especially oriented to the teaching of physics and chemistry, through a practical and individualised learning approach, to those who might have only mediocre science backgrounds but whose overall degree programme and career prospects would benefit from such a curricular input. Many young women, even those of high academic ability have in some ways 'lost out' in science as they have progressed through the educational system and may only realise at some advanced stage that they actually require further scientific knowledge. The organisation of such a degree course enables students to discover and come to terms with this finding.

It was considered by staff that the reasons why the course was attracting a number of women was that 'physics and chemistry' was not mentioned in the title and an attractive course description was used for advertisement purposes. Moreover, the staff tried to make the curriculum relevant to the lives of those taking it and to encourage learning by students' own exploration of the concepts, through practical studies, carried out at their own pace, and with adequate staff support. The one-year course curriculum is a balance of approximately 33 per cent physics and 67 per cent chemistry and is split equally into lectures/seminars and practical work with 11 one-hour tutorials held fortnightly. The students are expected to undertake between 20 and 30 experiments from a list drawn up by the staff and to complete three 'substantial work assignments'. The stated aims for this course are:

i. To give some insight into the concepts, fundamental laws and language of physical science.
ii. To outline the laws and concepts of physical science that are particularly relevant to earth and life sciences.
iii. To develop an appreciation of the scientific method.
iv. To develop practical ability in some of the fundamental experimental techniques relevant to physical sciences.
v. To develop the students' powers of observation and ability to interpret experimental data.

The course is one which can be taken at any point during the three-year combined studies degree. The college prospectus suggests one example of how the unit might fit into the overall curricular programme of a student who had a strong interest in mathematics, the life and physical sciences and wished to develop all three:

First Year
  Pure Mathematics
  Biology of Man
  Computing
Second Year
  Pure Mathematics
  Biology of Man
  Matter, Energy and Chemical Change
Third Year
  Pure Mathematics
  Materials Studies

5.8.2 The students

The students were visited during one of the practical sessions when they were engaged upon a variety of experiments from the list provided. There were approximately 12 pairs of students in the laboratory and two staff members in attendance in addition to technicians. Approximately one third of the students present were women, although this had been even higher the previous year. There was a range of ages amongst the students but most of the women were in the 18-25 age group. In discussing the course with the women, it emerged that some of the students taking the course had very little science in their backgrounds, some not even at 'O' level standard. As in previous discussions, they tended to cite physics aspects of the curriculum as being the most difficult and the staff mentioned that they needed a great deal of support. Two of the women mentioned that upon starting the degree course they had not had any intention of taking the physical science option, but once into the programme they had begun to realise the importance of the course. This finding is in line with comments made by Swarbrick (1980) after her study of women students taking the Open University Foundation course in Technology. When asked what types of career they were hoping to follow, the students mentioned teaching or some career in the earth or biological sciences. It was obvious, however, that one or two of the younger women had little idea of what qualifications and backgrounds were necessary to enter their chosen career. For instance two students interviewed during an earth science class wanted to be a hydrologist and a meteorologist respectively; neither knew that such occupations demanded a high level of training in mathematics and physics. Of those who mentioned teaching as a career, they thought that experience of physical science would be an added recommendation for them when they sought their first teaching posts. It was generally agreed that whatever the outcomes career-wise, the Matter, Energy and Chemical Change course was highly enjoyable if somewhat difficult. Others who had already taken the course felt that all the main science options on the degree course entailed a great deal of private study and reading. It was alleged by staff that the success rate amongst both women and men who had taken the course was very encouraging.

The Head of School, in commenting upon his hopes for the Combined Studies Degree course in Science, considered that there was a need for personnel who might enter the teaching profession, take up managerial and other white-collar jobs who had a broad knowledge of science. The Head was hoping that such graduates would create a spin-off effect and so encourage more able people to enter science or to enter the professions with a higher level of scientific skill.

5.9 Teaching Women Science Within the Home Economics Area

5.9.1 The problem

Many women have remained on the fringes of science during their education and have left school or college with little idea of what such disciplines have to offer. There is a tendency to believe that science is beyond their ability and that scientific principles are cloaked in a mystique which is understood by only a few of their sex who are presumed to be in some aspects, 'different' from the rest. These misconceptions have been passed on from generation to generation because no one has investigated such anxieties and their relationship to how science has been taught and presented. It has already been observed that, for the most part, college science staff believe that the women students whom they have taught are equally, if not more, proficient than the men in scientific abilities. They tend to conclude, therefore, that no problem exists and if it does, then it can only be dealt with in the schools. However, women taking science courses in Further and Higher Education are in many ways a self-selected group who are likely to have chosen science not only because of innate ability but also because of favourable experiences and encouragement received throughout their education. The problems and anxieties of the greater mass of women in relation to science may not show themselves in this population. Where they will tend to have external expression will be in those who have not studied science in any depth while at school and have not experienced any special motivating influences but who, for some reason are required, or feel the necessity because of career demands, to take a science course at some later stage.

One such group of women can be found in the domain of home economics which has seen major changes in its curricular content over the last fifteen years. Traditionally little science has been incorporated into many home economics courses whether at school or college level, the emphasis being predominantly on the practical and craft aspects of the subject. Working in Further and Adult Education, Hilary Davies found that women attending Home Economics/Catering courses were not prepared for the scientific approach essential for an understanding of the properties of food and the principles of nutrition. The scientific aspects of the syllabus gave rise to much anxiety amongst women and consequently a range of teaching strategies was devised to encourage and interest women in these areas. Recently the effectiveness of these teaching approaches designed to allay anxiety amongst women students studying science has been investigated.

The research study was centred on home economics teachers attending short in-service courses at Ilkley College – a series of science courses designed specifically for teachers with perhaps limited scientific background knowledge to teach the Food Science/Nutrition elements of the revised 'O' and 'A' level syllabuses in Home Economics introduced by the Joint Matriculation Board in 1974 (Davies, 1980).

5.9.2 The project

It was felt that, upon starting the research study (which utilised the population of home-economics teachers taking the new, in-service courses) there was a primary need to identify whether in fact the problem of women's anxiety existed in measurable terms. A preliminary investigation was conducted to ascertain whether science was popular amongst home economics teachers in three different regions. The results of this questionnaire survey revealed that, irrespective of age, years of teaching experience or geographical region, 'Household Science' was the least popular of all topics in home economics. 'Food Science' was also the second least-popular area for teachers of over 30 years of age. Three groups of students taking the short courses were identified for the main study including one control group of 'design' students.

Measures of anxiety-proneness (A-trait) were determined and situational anxiety (A-state) was measured (a) after applying for the courses, (b) just before the course began and (c) at the completion of the course. Whilst the test results showed that anxiety prone individuals did not react in quite the same way between measurements (a) and (b) as previous research had indicated there was a significant reduction in the number of expressed anxieties when teachers attended the courses a second time.

A study was also carried out into the types of course-related anxieties expressed by students. Items were tested which related 'to the maintenance of self-esteem', 'to the content and methods of science' and 'to the environment of the course'. It was discovered that the most common anxieties were those that related to students' self-esteem, whilst, of those factors directly related to the content of science courses, anxiety relating to chemical formulae and equations was frequently mentioned.

5.9.3 Developing appropriate teaching strategies

It was noticed that upon first starting science teaching women were quiet and uncommunicative. The tension was, however, reduced when the class was divided into small groups for practical work. As a result it was decided to capitalise on this information and to create a non-threatening environment for the classes. Luckily a suite of three, inter-linked rooms was available which included a kitchen area, a multi-purpose area and a science laboratory. Students met initially in the multi-purpose room which was made to look attractive and 'kitchen-oriented'. Students were told that they could perform their science practicals where they pleased; all initially chose the kitchen area. When confidence had been raised and when students had begun to realise that the kitchen was not as convenient for experiments as it might be, it was suggested that students should move into the laboratory. A further strategy was to allow the women to weigh out substances in teaspoons or cups and to measure liquids in quarter pints. As their confidence grew students began to use beakers and measuring cylinders so moving towards more confident use of scientific apparatus.

As formal lectures inhibit discussion and participation, introductory talks were kept to a minimum and only provided the minimum of theoretical background. Instead, carefully constructed work sheets were handed to students (composed of suggested experiments and study materials) for them to work through at their own pace in small groups where all could participate. The tutor was therefore able to move from group to group guiding learning but in addition providing personal encouragement and support for each course member according to her needs. Text and sourcebooks were available so that students could obtain the information they required. One of the most important elements of this teaching approach particularly for women in Further Education was that the work sheets were written in everyday language, 'the language of the learner', for experience had shown that scientific language and terminology could be particularly off-putting to those with no scientific background. Despite the use of non-scientific language, concepts were introduced, moving from the women's existing knowledge, language and interests towards the more formal methods and language of science.

The reader can gain a better appreciation of how teaching approaches in science can be adapted in this way so as to utilise students' everyday knowledge and language by reference to Appendix 5 where the author of the development studies described in this section has kindly provided some exemplary materials.

In order to determine whether the above-mentioned strategies had been successful, statistical comparisons were made between students attending the courses for the first and second times. A significant reduction in the level and the number of expressed anxieties was found to exist between the two groups, indicating that a measure of success had been achieved. It was recognised, however, that as student sample numbers in the research were relatively small, the work should be treated as pilot studies which could form a basis for more extensive investigation. Despite this problem, the research has provided some of the very few clear pointers and concrete proposals available as to why and how current scientific teaching practices within Further Education should and can be examined with a view to making modifications which might help women (and probably also some men) to overcome their anxieties and enjoy the study of science. Introductory programmes, of the nature described earlier in this chapter, might be considered the most appropriate courses where such strategies could be implemented with greatest effect although they may also be applicable to the school situation and to higher-level curricula.

5.10 Summary of Case-Study Findings

It can be seen from the women students' comments described in this chapter that there was a certain uniformity amongst their responses. Even though these were representatives from that small, select group of women who had found the necessary motivation to pursue a non-traditional career, it was obvious that, for the majority of those interviewed, there had been a number of problems to overcome. These chiefly related to a lack of basic scientific knowledge and skills, caused by inadequacies in their school backgrounds, which had placed them at a disadvantage when they began their training. It was also apparent that for a considerable number the motivations which had led to their choosing science-based courses and careers had arisen after they had left school. In some cases these older women students had the necessary basic qualifications to enter technical work but were seeking training which up-dated their knowledge and enabled them to regain lost confidence. This factor also emerged as a result of research into why so few women entered apprenticeships in the United States. By the time the American women had realised that they might pursue a technical career, they had passed the upper age limit of entry.

Most of the women interviewed spoke of the help and consideration which they had received from college staff and how much better they found the science teaching at college than at school. However, some did feel isolated, especially if they had been used to studying with other females, and felt that they had to prove themselves with their male peers and needed to make a special effort to 'fit in'. It was interesting to note that the women students did not, as some American research suggests, identify female role-models at school, college or in the professions as being important motivating influences on their choice of careers. One reason for this may have been that there were no suitable women available to fulfil this role. A very significant proportion did, however, mention the influence of friends and relatives who were usually male.

There was also general agreement about which aspects of the courses they found to be the most difficult. Physics and mathematics were the two most commonly mentioned by both staff and students, with the acquisition of workshop skills being identified as a problem at the start of the courses. It appeared that, as suggested earlier, the first few weeks or months of science ,and technical courses are a trying if not a critical period for women. The ordering of curricular content can be one important means through which staff can help to ease students, who are low in confidence, into the courses. Rather than by plunging directly into scientific theory and principles in a well-meaning attempt to help redress any deficit in students' backgrounds it would seem, from the case study data and some other Heads' comments, that a gradual approach to the theory, starting from examples and situations which are already familiar to students, is more beneficial. For instance women TOPS students taking laboratory-technician courses mentioned the difficulties and anxieties which they had encountered because organic chemistry, a subject that involved considerable rote learning, had been timetabled at the start of the chemistry syllabus. By contrast they perceived physics (which for many women is found to be very difficult) to be highly enjoyable and understandable because the lecturer concerned had been prepared to spend time applying the theory to everyday examples. In the case-study where science was being taught to home economics teachers, it was revealed that simply by starting the course in the more familiar surroundings of a kitchen rather than a laboratory, students' fears could be markedly reduced. The implementation of small-group or individualised teaching was mentioned in several different cases as a means of helping students to gain confidence in non-traditional environments. Moreover, the renaming of the 'Physics and Chemistry' unit as 'Matter, Energy and Chemical Change' in the modular degree course examined, was considered to have been one positive factor which encouraged a good take-up by women of this unit. The concept of using everyday or non-threatening language when teaching science to women in order to promote their attitudes and learning was developed in much greater depth in the home economics case-study. As Appendix 5 reveals, a question such as:

> What is meant by the 'denaturation of protein by heat'? Explain the process using the effect of heat on egg protein to illustrate your answer.

can be transformed, with equivalent meaning, into:

> Scrambled egg thickens with heat. Name this thickening process and explain how thickening takes place using diagrams where possible.

The case studies provide examples of the types of science and technical courses within Further Education which are beginning to attract women students albeit in small numbers. These courses are not confined to any particular subject area or discipline. There usually appears to have been some identifiable factor/s which might be supposed to have had a favourable effect on those women students who were able to exercise a degree of choice, whether as a result of (a) supportive or open-minded staff attitudes; (b) the general atmosphere of the department; (c) the level of outreach activities; or (d) the course content and teaching. For those women interviewed who were already in work, their employment by large rather than small companies appeared to have some influence on their participation in day- and block-release programmes. It might be anticipated that large concerns would have a definite training policy regarding their employees so that all trainees of appropriate ability, irrespective of sex, would be released to college; this might not be so for small companies. Few departments have gone out of their way to attract women students, however, or to adopt specific teaching practices which might particularly help them. The work described in Section 5.9, which has been carried out in one of the fringe areas of physical science is seen to be particularly important in this respect and indicates how useful developments might be made.

CHAPTER 6

Summary and Conclusions

6.1 Women's Entry into Science and Technology

1. There are several arguments for wishing to encourage more women to enter science and technology courses and careers:
    i. There is a large potential source of science and technical expertise which has as yet not been explored.
    ii. There is a shortage of qualified personnel in a number of areas within the science and technical fields, especially for professional engineers, technicians and technician engineers and for science and craft teachers in schools.
    iii. Job opportunities in traditionally women's occupations are currently receding faster than in many other employment areas.
    iv. Women and men have, as individuals of equal status in society, the right to fulfil as equal a role as possible in all aspects of working life.
2. With regard to the question of the poor participation rate by women in the fields of science and technology, Further Education is in the invidious position of inheriting a difficult problem which started much further down the line. It is obvious that inadequacies in women's scientific backgrounds occasioned by attitudes and practices in the schools are a major hurdle to women entering and succeeding in science and technology. It is not accepted, however, that there is nothing that staff in Further Education can do to help improve this situation. A list of possible strategies is provided at the close of this chapter.
3. The nature and presentation of all curricula have, to a lesser or greater extent, an influence on subsequent student take-up, even though the effect may not be immediate or easily attributable to one specific cause. News of the extent to which a course is interesting and meeting the needs of the target group is transmitted to potential students and employers via an informal network of contacts. Curricular factors, therefore, can never be dismissed from discussions regarding students' take-up even though there may be potent socialising influences at work both inside and outside the colleges.
4. There is a complicated pattern of women's take-up of science and technology courses influenced by a multiplicity of possible factors including: innate cognitive variables; personality traits; educational and family backgrounds; parental, teacher, peer-group and employer attitudes and influences in addition to the attitudes of the women themselves; current employment prospects; course publicity and the dissemination of information and issues relating to curricular structure, teaching and content.
5. There is a consensus of opinion amongst researchers and the Heads of Department questioned during the present survey that girls and women have significantly poorer attitudes, and hence motivations towards science and technology, than boys and men. Several intervention projects conducted in Britain and America have indicated that girls' and women's attitudes to science, and hence their subsequent subject and career choice, can be improved by the utilisation of suitable remedial strategies implemented on a sustained basis. It is generally accepted that, as the formation of attitudes takes place from early childhood onwards, such activities should begin as soon as possible.
6. When the questionnaire student enrolment data for the 1979/80 academic session are compared with government statistics for 1977, it can be observed that, while women have shown a noticeable increase on Further Education courses within all the main scientific disciplines, their participation rate in technology courses, particularly at craft and technician levels, has remained almost static.
7. From the project's survey of initiatives which might encourage more women to enter science and technology, it appears that the most positive and immediate results have been achieved through efforts which have been clearly and carefully targetted at women than through initiatives of a more generalised and diffuse nature. Positive results are likely to be seen, however, from any activity which helps to bring students and school children into closer contact with science, technology and industry. The current moves to improve school-industry links and to expand YOPS, STEP, Job Creation and Work Experience programmes, for instance, may in the future produce worthwhile results. In addition the student interview data revealed that staff in local Job Centres and companies, by the organisation of open days and related activities, have an important role to play in encouraging more women into technical careers.
8. The chief methods by which many scientific and technical organisations are attempting to ensure that the concept of equal opportunities is enacted within their spheres of influence are through the medium of careers guidance and the issuing of policy statements and guidelines. Whilst practice varies, most organisations are now attempting to portray and describe women working alongside men in a variety of scientific and technical tasks in their careers literature. Few, however, are making efforts of a more determined and specialised nature, the EITB and to a certain extent the MSC being notable exceptions.
9. Sex stereotyping in written and pictorial materials, especially those disseminated through the media, is a subtle but pervasive way through which women's subject and career choices are restricted. The varied attempts presently under way to eradicate this problem are likely to have a beneficial effect upon widening women's aspirations and so promote their entry into non-traditional spheres. The results of such initiatives are likely to be observed in the medium- to long-term rather than immediately.

10. The principal efforts being made by college departments to attract higher numbers of women students are mainly through the establishment of links between the department and local schools or through emphasis of the concept of equal opportunities in their careers literature. Link courses and talks by departmental staff at schools' careers conventions were not considered to have had a noticeable pay-off in terms of student numbers, female or male.
11. There was a feeling expressed by many senior college staff and members of scientific and technical organisations that the implementation of a policy of positive discrimination towards women, in order to encourage them to choose science-based careers, was neither feasible nor desirable. Some Heads of Department claimed that such actions were unnecessary because women students who had passed through their departments had been of high calibre and motivation. It is clear, however, that women currently choosing non-traditional career pathways are a highly self-selected group, few in number and not representative of the general population of potential women students.
12. The influence of role-models upon girls' and women's course and career choice would appear to be important. The student take-up data and the female/male staffing ratios for the sample departments provide further evidence that women students are influenced by the presence of women academics in science and technology. Where women have locally gained a foot-hold in these non-traditional fields, therefore, there is a tendency for others to follow. Such findings provide support for the financial and other initiatives being implemented by one or two training boards and related organisations in order to 'seed' industry and the professions with talented women. In the college situation, the utilisation of women academic staff in departmental outreach activities might be supposed to have a beneficial effect upon subsequent women students' enrolments.
13. The interviews with women students currently engaged upon science and technology courses within Further Education revealed that in a significant proportion of the cases a relative, almost always male, had exerted a decisive influence on their non-traditional career choice although not specifically on their choice of course or college.
14. The questionnaire results indicate that course duration may be a take-up factor where women are concerned. Their participation rate on science and technology courses within the sample population tended to fall appreciably for course lengths in excess of two years. Women's attitudes and domestic commitments may not be entirely the cause of this result; employers may not be prepared to invest in prolonged training for women and careers officers or teachers may steer them away from courses of extended duration.
15. Given that women tend to enrol in lower proportions on courses of long duration and often have domestic commitments to contend with at the same time as they are pursuing educational and vocational goals, the provision of courses of an additive nature which can be built upon at another time and in another place are particularly beneficial. The greater utilisation of individualised learning packages, which enable women to study on their own when it is convenient and, more specifically, could help them to overcome any deficiency in their scientific backgrounds, is to be recommended. Similarly, the timetabling of more courses within school hours would facilitate the participation of women in all types of mainstream college provision.

6.2 Curricular, Teaching and Learning-Related Issues

1. Several ability factors might be expected to have some bearing on scientific ability and learning. These are:
   i. Verbal ability
   ii. Visuo-spatial ability
   iii. Mathematical ability
   iv. Manipulative ability.
   v. General ability or intelligence

   Previous research indicates that there is a varying degree of interrelationship between these factors.
2. Research findings also indicate that girls tend to achieve a higher level of success in traditionally female-dominated disciplines and skills, such as English, foreign languages and verbal ability than boys and men. Boys, meanwhile, achieve a higher level of success in the sciences and technology and tests of visuo-spatial and mathematical ability. As the student populations taking science and technical courses within Further Education are to a certain extent self-selected, and this is probably truer in the case of female students, no firm conclusions can be made about sex differences in performance within the general student population at this level.
3. The magnitude of measured sex differences in performance and tests of ability tends to vary between cultures, between researchers, between neighbouring schools or colleges and over time. This suggests that innate, biologically-determined factors may not be so important to the development of observed sex differences as has been previously thought whilst the effect of socialising influences may be much greater. There would appear to be no fundamental reason, therefore, why women cannot succeed within the science and technology fields.
4. The research suggests that much of women's lack of motivation towards science and technology may be attributable to their lack of correct, up-to-date information concerning these spheres. College departments can go some way to improving the flow of information to girls and women through their course publicity and outreach activities. There may also be something to be gained from allowing students the chance, where possible, to 'shop around' the curricular opportunities available during their first year of college in order to gain more appreciation of the worth of science-based options.
5. There is some indication that many women only gain the necessary information about, and motivation towards, non-traditional careers, after they have left school and started work. By then several occupations such as those tied in to the apprenticeship system may be closed to them and ways of opening up these opportunities for older trainees could be more actively explored. Study opportunities for mature students which provide access into scientific careers are especially helpful to women.
6. It is obvious that even those women who are pursuing careers in the sciences and technology tend to have deficits in their scien-

tific backgrounds and lack the range of formal qualifications possessed by their male peers. Many of these women, nevertheless, do possess the necessary ability and motivation to succeed in technical spheres, and it would appear important, therefore, that colleges should allow some flexibility in their entry requirements for many courses and be prepared to set their own entrance tests for those who do not possess standard qualifications.

7. The student interview data suggest that young women may be in a more vulnerable position than young men in the transition from school to college or school to work. The first few weeks or months of a non-traditional course may be crucial for women's confidence and progress and it is therefore necessary for staff to be particularly sensitive to any problems exhibited during this time and to provide a supportive study environment. There are some indications that women may have a higher drop-out rate on science and technology courses than men, particularly in the early months. While some further research is required in this area, it appears that they would benefit from some special counselling at the start of the courses which would promote the settling-in process and prepare them for possible difficulties. Whilst easy access to counselling services is important for all those studying in a non-traditional environment, it is also apparent that, with encouragement, such students can help themselves and form mutually supportive groups.
8. Introductory courses are an important means of access into mainstream college curricula for those who have not acquired the necessary background. They are of great value in helping women in particular to gain confidence and skills in order to succeed upon science and technology courses alongside men. There appears to be a current need for more skills-based introductory courses which would help more women to gain entry into apprenticeships and craft-level opportunities. There is also a growing need for basic courses which help women to enter occupations related to the implementation of 'the new technology' such as in the information-exchange area.
9. College staff may also be able to help overcome women's initial lack of practical and workshop skills displayed upon starting science and technical courses through expanding their tutorial provision at this stage and/or providing more remedial classes for those exhibiting difficulty.
10. Attitudinal research reveals that differences in classroom behaviour between girls and boys continue into the college situation. Women are said to prefer more structured learning environments than men and to be 'watchers' rather than 'doers'. The questionnaire findings indicate that Heads of Department had not in the main observed this to be true, although when asked in which learning situations women appeared to make best progress, the more structured situations were mentioned.
11. The difference between research findings and the views expressed by Heads of Department regarding women's learning preferences and problems may occur because, as mentioned previously, women science/technology students are a highly selected group. In order to perceive and to investigate the learning-related preferences, anxieties and problems of the greater populace of women in relation to science, it may be necessary to examine instances where women have been required to study science as a part of another course, such as in the example discussed in Section 5.9, where fearful and negative attitudes and an initial deficit in scientific knowledge had to be overcome.
12. The present research has highlighted the importance of teacher attitudes to girls' subject and subsequent career choice. In-service training courses (such as that described in Section 5.9), which help teachers within the arts, social science or home economics area to become more familiar with science and to appreciate its importance in everyday life, are means through which the next generation of women can be motivated towards a wider range of careers.
13. A further factor which may have influenced Heads of Department's reluctance to identify gender-related differences in learning and curriculum-related issues may be because they are alerted to the wider implications of the Sex Discrimination Act and the current concern with 'equal opportunities'. Some may have felt that they should not perceive any differences.
14. On the question of students' scientific skills, of those providing a response on the questionnaire:
    2 per cent considered that women had less natural ability than men due to innate factors,
    25 per cent felt that there was no overall difference in women's and men's skills, and
    61 per cent felt that a practice deficit, occasioned by socialising influences was the root cause of any lack of scientific skills shown by women and that this could be remedied by increasing the opportunities for females to gain familiarity with these techniques, starting at as early an age as possible.
15. While in America there is a growing trend for colleges to make special provision for women through designing single-sex courses which help them to gain access into non-traditional careers, by comparison there are few examples of such provision in Britain and the project questionnaire results revealed that college staff were not as a whole in favour of following the American example. In order to help women's entry into, and progress within, science and technology through curricular means, therefore, the way ahead would appear to lie through modifications to curricular and teaching approaches.
16. There is a growing body of evidence from this and other surveys which suggests that students, and women in particular, are especially motivated towards science-based curricula which:
    i. Discuss the social and environmental implications of science,
    ii. Are not over-loaded with theory,
    iii. Provide plenty of practical examples of the theory, especially those which are directly relevant to students' own lives.
17. The case study results also indicate several teaching approaches which would help women and other students who are unsure of themselves to settle into the courses. These are:
    i. Providing a gradual introduction to theoretical concepts,
    ii. Ordering the curricular content so that the easier and more appealing topics are taught first,
    iii. Utilising small-group or individualised teaching methods, and providing plenty of staff-student contact,
    iv. Reducing the number of obscure scientific terms used

and replacing these, where possible, with everyday words and phrases.

18. The research suggests that there is a need for inputs into in-service training activities for college staff, not only to help them consider modifying their teaching approaches in order to accommodate the needs and preferences of women students but also to indicate to them how to implement equal opportunities guidelines such as those suggested by the EOC which are reproduced in Appendix 4.

19. In order to indicate to college staff the range of possible strategies open to them the list of strategies suggested at the close of Chapter 3 is restated below:

a. Organisation

- i. Improve careers guidance materials aimed at women
- ii. Improve course-related publicity generally
- iii. Improve outreach activities and promote school-industry links
- iv. Revise/scrutinise admissions policies
- v. Establish scholarships and provide financial incentives for women
- vi. Appoint co-ordinator to oversee initiatives and the provision of equal opportunities
- vii. Keep accurate statistics by sex
- viii. Timetable more courses within school hours
- ix. Run more courses of a modular nature
- x. Help women on non-traditional courses to make contact with other women
- xi. Provide child-care facilities
- xii. Combat sex-stereotyping in education generally
- xiii. Change attitudes of teachers, lecturers and peers

b. Curriculum and Teaching

- i. Make special curricular provision for women
- ii. Develop more and varied introductory courses
- iii. Involve more women as role-models and teachers
- iv. Provide supportive classroom atmosphere
- v. Extend counselling provision for those studying in non-traditional environments
- vi. Provide more job-sampling opportunities within or outside the curriculum
- vii. Institute compensatory classes in scientific skills
- viii. Reduce theoretical aspects of the courses and provide more practical examples of the theory
- ix. Raise the humanistic content in science courses
- x. Utilise/develop more teaching materials which include females and topics of female interest
- xi. Value women's qualities, i.e. good report writing and their meticulousness
- xii. Encourage girls not to drop science while at school.

The above conclusions and suggested strategies, taken together, encompass a wide range of options for college staff to consider as possible means by which they can modify and develop their provision and teaching so as to take more account of the needs of women students. The greater challenge to be met, however, is to find ways of increasing the participation of women in the scientific and, more particularly, the technical departments. It is hoped that this report goes some way towards providing insights into how this might be achieved.

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APPENDIX 1

QUESTIONNAIRE

NATIONAL FOUNDATION FOR EDUCATIONAL RESEARCH IN ENGLAND AND WALES

The Mere, Upton Park, Slough, Berks. SL1 2DQ

WOMEN IN SCIENCE AND TECHNOLOGY PROJECT

College/Polytechnic ....

Department ....

Departmental Address ....

Name ....

Appointment ....

The project is concerned with the curriculum, organisation and teaching approaches of a selection of science and technology courses within the Further Education sector. Our major aim is to identify factors associated with women's take-up of such courses and to examine curricular issues which particularly affect female students' subsequent progress and attainment.

The questionnaire seeks to explore departmental policies, your views relating to the needs and problems of women students and the take-up by women of the various courses which you offer.

We hope that you will feel able to participate in this research by completing the questionnaire. Please indicate your answers by either circling the appropriate number or writing in the space provided. A stamped, addressed envelope with a pre-paid label is enclosed in which you can return the completed questionnaire.

I. THE COURSES

1. Please complete the following data sheet to provide details of the Full-Time, Sandwich, Block Release and Part-Time courses which you offer. (Exclude courses outside science/technology.)

Course and/or subject	Qualification	Duration (Years/weeks)	Student Numbers		NFER Use
			Women	Total	
Full-Time Courses					
1.	....	....	....	....	6–16
2.	....	....	....	....	17–27
3.	....	....	....	....	28–38
4.	....	....	....	....	39–49
5.	....	....	....	....	50–60
6.	....	....	....	....	61–71 79–80/01
7.	....	....	....	....	6–16
8.	....	....	....	....	17–27
9.	....	....	....	....	28–38
10.	....	....	....	....	39–49
Sandwich Courses					
1.	....	....	....	....	50–60
2.	....	....	....	....	61–71 79–80/02
3.	....	....	....	....	6–16
4.	....	....	....	....	17–27

data sheet continued over page

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Course and/or subject	Qualification	Duration (Years/weeks)	Student Numbers		NFER Use
			Women	Total	
Block-Release Courses					
1.	....	....	....	....	28–38
2.	....	....	....	....	39–49
3.	....	....	....	....	50–60
4.	....	....	....	....	61–71 79–80/03
5.	....	....	....	....	6–16
Part-Time Courses					
1.	....	....	....	....	17–27
2.	....	....	....	....	28–38
3.	....	....	....	....	39–49
4.	....	....	....	....	50–60
5.	....	....	....	....	61–71 79–80/04
6.	....	....	....	....	6–16
7.	....	....	....	....	17–27
8.	....	....	....	....	28–38
9.	....	....	....	....	39–49
10.	....	....	....	....	50–60

NFER Use

II. STAFFING

2. Please indicate the number of LECTURING and TECHNICAL staff which you have in your department by completing the following table.

Staff		Number	
		Lecturers	Technical
Full-Time	Men		
	Women		
Part-Time	Men		
	Women		
Total			

61–64

65–68

69–72

73–76

79–80/05

III. VIEWS AND POLICIES – STUDENT TAKE-UP

3. Traditionally, women students have formed a minority amongst those choosing most types of science and technical courses. What do you consider to be the most important factors which govern the take-up by women of SCIENCE and TECHNICAL COURSES?

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NFER Use

4. Does your department make any special efforts to attract women students?

Please circle

If YES, please give details.

Yes No
1 2 — 8

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.... 9–10

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5. Are there any courses in your department which, to your knowledge, CONSISTENTLY attract a higher female take-up than courses for similar subjects offered by other colleges?

Please circle

Yes No Don't know
1 2 3 — 11

If YES, please give details.

....

.... 12–13

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6. Are there any changes or developments which you think might be introduced to attract higher numbers of women students into your department?

Please circle

If YES, please give details.

Yes No
1 2 — 14

....

.... 15–16

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NFER Use

IV. VIEWS AND POLICIES – ASSESSMENT AND PERFORMANCE

7. Does your department employ any of the following assessment methods:

	Please circle Yes	No	NFER Use
a. continuous assessment?	1	2	17
b. assessment by examination?	1	2	18
c. other assessment method/s?	1	2	19

If YES, please give details.

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8. Does your department employ:

	Please circle Yes	No	NFER Use
a. written exams – multiple choice?	1	2	20
b. written exams – essay type?	1	2	21
c. practical exams?	1	2	22

9. It has been suggested that while women tend to do at least as well as men in essay-type exams, they are at a disadvantage in practical and multiple-choice exams. Please circle the appropriate number which closest corresponds to your views on this issue.

	Women do better	Women same as men	Men do better	NFER Use
a. written exams	1	2	3	23
b. practical exams	1	2	3	24
c. multiple-choice exams	1	2	3	25

10. Do you consider that women GENERALLY do as well as men on science and technology courses?

	Please circle Yes	No	NFER Use
Please comment	1	2	26

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			NFER Use
11. Are there any COURSES AND/OR SUBJECTS offered by your department in which you consider:	Please circle		
a. women do as well as, or better than, men?	Yes 1	No 2	28
If YES, please say which			
....			29–30
....			
b. women do less well than men?	Yes 1	No 2	31
If YES, please say which			32–33
....			
....			

V. VIEWS AND POLICIES – TEACHING AND LEARNING

	Please circle		
12. Does your department place a particular emphasis on any one type or combination of teaching approach/es such as lectures, demonstrations or practical work?	Yes 1	No 2	34
If YES, please give details.			
....			
....			35
....			
	Please circle		
13. Does your department provide:	Yes	No	
a. group tutorials?	1	2	36
b. individual tutorials?	1	2	37
c. any other special help for those encountering study difficulties?	1	2	38
If YES, please give details.			
....			
....			39
....			
	Please circle		
14. Do you consider that there are any study skills with which women have more problems than men?	Yes 1	No 2	40
If YES, please give details.			
....			
....			41–42
....			

NFER Use

15. Previous research has indicated that men and women may prefer to learn in different ways. Please circle the appropriate number below to indicate your views about the preferences of men and women to the following learning situations:

	Women prefer	Same as men	Men prefer	Don't know	NFER Use
a. theoretical lectures	1	2	3	4	43
b. demonstrations	1	2	3	4	44
c. group practicals (structured*)	1	2	3	4	45
d. individual practicals (structured*)	1	2	3	4	46
e. group practicals (unstructured) also known as 'discovery learning'	1	2	3	4	47
f. individual practicals (unstructured) also known as 'discovery learning'	1	2	3	4	48
g. individual study (outside classes)	1	2	3	4	49
h. other	1	2	3	4	50

* Structured practicals are those in which students complete tasks or experiments organised and designed by the tutor.

16. It has been suggested that women make better progress in small rather than large groups and in all-women rather than mixed classes. Please circle the appropriate number to indicate your views on this issue.

Women make better progress in:	Agree	Disagree	Don't know	NFER Use
a. small groups	1	2	3	51
b. all-women classes	1	2	3	52

17. Are there any learning situations (whether mentioned in Questions 15 and 16 or not) in which you consider women do particularly well?

	Please circle Yes	No	NFER Use
If YES, please give details.	1	2	53

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NFER Use

VI. VIEWS AND POLICIES – ATTITUDES AND ACHIEVEMENT

18. Please circle the appropriate number to indicate your views on the suggestion that women have less favourable attitudes to science and technology than men.

Agree	Disagree	Don't Know
1	2	3

56

19. There are some indications that women's attitudes to science and technology can be improved if greater use is made of PEOPLE-ORIENTED subject matter within such courses and more account is taken of the SOCIAL IMPLICATIONS of science and technology. Please circle the appropriate number to indicate your views.

	Agree	Disagree	Don't know	NFER Use
a. greater use should be made of people-oriented subject matter	1	2	3	57
b. more account should be taken of the social implications of science and technology	1	2	3	58

20. Are there any course materials which, in your experience, are particularly welcomed by women students?

Please circle
Yes No

If YES, please give details. 1 2 59

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.... 60–61

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NFER Use

21. Good visual/spatial skills are often said to be the basis for success in science and technology. Whilst past research has recorded that, on the whole, women tend to have innately lower visual/spatial ability than men, some recent findings have suggested that this is not so, and that women simply have a 'practice deficit' in these skills which can be remedied by suitable strategies.

a. What are your comments on this issue?

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.... 62–63

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b. Based on your own experience, what strategies could you suggest to increase women's scientific skills?

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.... 64–65

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VII. VIEWS AND POLICIES – CAREERS

22. What facilities are available to help science and technology students select a future job or career:

a. in the college?

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.... 66–67

....

b. in your department?

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.... 68–69

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☐	☐	☐	☐	☐
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NFER Use

23. Does your department offer any special introductory or preparatory courses for those who have little or no previous experience of science or technology?

Please circle
Yes 1 No 2

If YES, please state the course names. 70

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.... 71

Which of these courses, if any, would be suitable for adult women who wish to return to work or to change jobs?

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.... 72

VIII. GENERAL

24. Which do you consider to be the chief difficulties facing women taking science and technology courses?

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.... 73–74

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25. If you have any other views on your science or technology provision with regard to women students, please comment below.

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.... 75–76

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.... 79–80/06

THANK YOU VERY MUCH FOR COMPLETING THIS QUESTIONNAIRE

Please return the questionnaire in the pre-paid envelope.

APPENDIX 2

ORGANISATIONS CONTACTED

Amalgamated Union of Engineering Workers (Technical and Scientific Staff Section)
American Society of Women Engineers*
Association for Adult and Continuing Education
Association of Colleges of Further and Higher Education
Association of Mining, Electrical and Mechanical Engineers
Association of Principals of Colleges
Association for Science Education
Association of Vice-Principals of Colleges
British Association for the Advancement of Science*
British Association for Commercial and Industrial Education
British Computer Society*
Careers Research and Advisory Centre
Ceramics, Glass and Mineral Products ITB
Committee of Directors of Polytechnics
Construction ITB*
Council for National Academic Awards*
Council for Engineering Institutions*
Electrical Association for Women*
Engineering ITB*
Environmental Health Officers Education Board
Equal Opportunities Commission*
European Centre for the Development of Vocational Training (CEDEFOP)*
Food, Drink and Tobacco ITB*
Industrial Society*
Industrial Training Research Unit*
Institute of Building*
Institute of Chemical Engineers*
Institute of Civil Engineering*
Institute of Engineers and Technicians*
Institute of Municipal Engineers
Institute of Physics*
Institute of Science Technology
Institute of Structural Engineers*
Institute of the Motor Industry
Institution of Electrical and Electronics Technician Engineers*
Institution of Metallurgists*
London and Home Counties Regional Advisory Council for Technical Education*
Manpower Services Commission – Special Programmes Division*
Manpower Services Commission – Training Services Division
National Association for Teachers in Further and Higher Education*
National Joint Training Commission for the Building Industry
National Water Council*
Petroleum ITB*
Royal Society of Chemistry*
Rubber and Plastics Processing ITB*
Technician Education Council*
West Midland Regional Advisory Council for Technical Education*
Women's Engineering Society*

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* Organisations who have replied.

APPENDIX 3

INITIATIVES AIMED AT REDUCING SEX-STEREOTYPING AND DISCRIMINATION AND AT WIDENING OPPORTUNITIES FOR WOMEN

3.1 Guides and Guidelines

i. 'Do You Provide Equal Educational Opportunities?' – a guide to good practice in the provision of equal opportunities in education. EOC.
ii. 'Equal Opportunities in Post-School Education' – a guide to the implications of the Sex Discrimination Act for post-school education. EOC.
iii. 'Sex Discrimination and the Equality of Opportunity'. Policy guidelines for post-school education. CNAA/EOC.
iv. The Schools Council has a working party on 'Sex Differentiation in Schools' and is in the process of producing 'Policy Guidelines for the Elimination of Sexism'.
v. 'Ending Sex-Stereotyping in Schools' – a source book for school-based teacher workshops. Prepared by Valerie Hannon for EOC.
vi. 'A Guide to the Equal Treatment of the Sexes in Careers Materials'. EOC.
vii. 'Guidelines for Equal Treatment of the Sexes in McGraw-Hill Book Company Publications'. McGraw-Hill.
viii. 'The Sex Discrimination Act and Advertising' – a guide dealing with recruitment and advertisement of goods, facilities and services. EOC.
ix. 'Fresh Start' – a guide to training opportunities for women who wish to return to work. EOC.
x. 'Women's Handbook' – policies and action for the Transport and General Workers Union.

3.2 Useful Publications

i. 'Breakthrough'. A pictorial record of five years' progress towards sex equality in employment. EOC.
ii. 'Ballet Shoes or Building Sites?' – the role of books, reading and libraries in the encouragement of girls to take up careers in engineering. Davey (1980). (Extensive bibliography.)
iii. 'Women and Education Newsletter' published several times a year and a good source of information on activities to reduce sex stereotyping and expand women's opportunities. With EOC support a special issue (No. 2) was produced during 1980 which contains a comprehensive bibliography of references, projects, materials and addresses of feminist groups and other organisations.
iv. 'Women and Training News'. Newly-launched newsletter of the Inter-Board Liaison Group on Training Opportunities for women convened by the MSC.
v. 'EOC News' – a bi-monthly publication which provides up-to-date information on initiatives relating to all aspects of 'Equal opportunities'.
vi. 'Women's Studies Newsletter' published under the auspices of Workers Educational Association. Also deals with issues outside the women's studies area.
vii. 'Vocational Training' published by the European Centre for the Development of Vocational Training (CEDEFOP) provides information on women's training opportunities in Europe.
viii. 'Women and Europe' a newsletter published by the EEC through its Directorate-General for Information for Women's Organisations and Press. Covers a variety of issues such as women and EEC legislation regarding education and employment.
ix. 'EOC Research Bulletin' Vol. 1, No. 3. Special edition providing educational and employment statistics relating to women in EEC countries and information on EEC legislation.
x. 'Training Opportunities for Women'. Survey published in 1975 by MSC on existing provision for women and made recommendations for developments.
xi. 'Opportunities for Girls and Women in the MSC Special Programmes For The Unemployed'. More recent survey (1979) of MSC training activities and the needs of women. Makes many useful suggestions.
xii. 'Training for Equality' – a survey of vocational training initiatives for women in the United Kingdom. Prepared by Marie Alexander for the MSC and CEDEFOP in 1979.

3.3 Projects

i. 'Girls into Science' project based at Manchester Polytechnic and sponsored by the SSRC/EOC Joint Panel on Women and Under Achievement.
ii. The Counselling and Career Development Unit at Leeds University run in-service courses for teachers aimed at reducing sex stereotyping in schools.
iii. YWCA amongst other activities is conducting a research programme to discover the issues and problems surrounding the employment of young women in their teens working in non-traditional jobs.
iv. 'Women in Manual Trades' project sponsored by the EOC is in the process of producing a report on women in the manual trades in Scotland, highlighting the problems they face and making recommendations for changes in training.
v. The EOC is also financing a 'supervisor' to provide encouragement and support for girl trainees in an MSC-funded aluminium foundry in Sheffield and to produce publicity material to attract girls to train in this traditionally male area.
vi. The Ashridge Management College has been, since 1977, conducting a research project sponsored by the MSC 'to identify the main factors in organisations which limit women's opportunities to become managers'.
vii. Projects and schemes undertaken by the MSC and ITBs which have been described in the main text.

3.4 Other Organisations Who Are Actively Involved

i. London and Home Counties Regional Advisory Council for Technological Education has established a Committee on Vocational Courses for Women and published 'The Vocational Education of Women' in 1976.
ii. The Yorkshire and Humberside Council for Further Education has produced a report on opportunities for women in post-school education and issued a policy statement.
iii. The Technician Education Council (TEC) has been reviewing its policies, with the aim of issuing guide-

lines where necessary, to ensure that women are catered for through its programmes.

iv. The General and Municipal Workers Union has set up national and regional 'Equal Rights Advisory Committees'.

v. Women's Engineering Association is involved with promoting women's access into the engineering industries and looking after their interests thereafter.

vi. Electrical Association for Women aims to improve women's knowledge about electricity generally and to help more women to become electrical and electronic engineers. Works through the Caroline Haslett Memorial Trust.

vii. Institution of Electrical and Electronic Technician Engineers is involved with the 'Girl Technician Engineer of the Year' award.

viii. Fawcett Society is a long established organisation acting in the area of equal rights and equal opportunities. Maintains a library and arranges meetings and conferences.

ix. National Association of Youth Clubs. Variety of activities.

x. National Advisory Centre on Careers for Women.

xi. Careers Research and Advisory Centre (CRAC) has sponsored a conference. Concerned with development of better careers materials and advice.

xii. West Midlands Engineering Employers' Association is involved with MSC in running single-sex management courses for women.

xiii. The Industrial Society runs, at intervals, the 'Pepperell Development Course for Women'.

xiv. The 'Women in Management' group is concerned with promoting women's career development generally.

xv. The Inner London Education Authority, as a result of an initiative by the National Association of Teachers in Further and Higher Education has, since 1970, maintained a Standing Committee on Careers Opportunities for Women and Girls. The remit of the Committee is to 'investigate the difficulties and lack of opportunities for girls to be employed in non-traditional occupations and at non-traditional levels and to consider ways of widening such opportunities'.

APPENDIX 4

EOC GUIDELINES REGARDING SCIENCE AND TECHNOLOGY

Source: Equal Opportunities in Post-School Education

Guideline

3.2 College prospectuses and leaflets must not state, or imply, that courses are not open equally to men and women, and care should be taken to ensure that nothing appears in publications which suggests this: e.g.

i. photographs showing only men doing engineering;
ii. statements such as 'courses for boys seeking a career in the building industry';
iii. requiring written assurances from women applicants that proper arrangements have been made for the care of their children.

3.3 Colleges must not place any requirement on students which cannot be justified as necessary and which might be construed as indirect discrimination: e.g.

i. that students must have had previous experience in an industry which has not normally employed people of that sex;
ii. that students must have had a minimum period of continuous employment.

3.4 Colleges must not discriminate against women in selection for admission to courses on the ground that, as women, they could less easily follow the course: e.g.

i. they would not fit into the 'rough and tumble' of workshops;
ii. they could not cope with the strains of working as a surgeon;
iii. they would find it difficult to obtain a training placement during the course or employment upon completion of their training.

4.3 Liaison between post-school institutions and schools should be developed, as much damage has already been done in terms of low aspirations and of the rejection of whole areas of vocational study by the time the post-school sector is reached. There should be an increase in the amount of information available to those in schools (teachers, pupils and parents) about the variety of courses available to students, including non-traditional areas of study for girls such as engineering, design, technology, business studies and the sciences, and about the career opportunities which could develop as a result of following such courses of study. This liaison could be developed to include joint staff seminars, in-service training courses and advisory groups.

4.6 All establishments providing courses should develop information and counselling services to ensure that the educational opportunities available are accessible to the whole community, and to provide help and information on educational and employment opportunities. This service should be available before, during and after the first contact through to the completion of the course. Any guidance given to students or potential students must be non-discriminatory, and lecturers, counsellors, etc. should ensure that they do not discourage students from considering non-traditional courses.

4.7 Special attention should be given to the continuing counselling services required by students who are in a minority on a non-traditional course, and in particular to the needs of the student who may be in an isolated position as the only person of her or his sex on a course.

4.12 Course organisers should consider increasing the number of courses designed to provide the unemployed or those wishing to return to work after a period of domestic commitment, with basic skills training or 'foundation' training. The first type of course could be designed to introduce adult students to basic study skills and gain experience of participating in group activities to counteract problems of social isolation, lack of confidence, low aspirations, etc. 'Foundation' courses could be planned as 'work experience' equivalents in non-traditional areas to provide background and initial skills training as preparation for more advanced courses.

4.13 Colleges should develop courses in non-traditional areas and should encourage and advise women on the possibility of extending their knowledge in such areas as a preliminary to employment or more advanced studies.

4.16 Colleges should consider developing courses which are modular and additive in structure, so that students are able to take breaks between modules without losing the credits previously gained.

4.19 Colleges, training boards, and other providers of courses should work with industry and commerce to promote actively the extension of post-school education schemes for young people so that post-school education, including day-release provision, becomes a recognised part of the employment pattern for all young people regardless of sex.

4.20 Colleges should obtain the necessary designation from the Secretary of State to discriminate positively in certain courses in accordance with Section 47 of the Sex Discrimination Act. (For example, a college must not run engineering courses for men only and it must not impose quotas on men or women entrants. It can, however, obtain designation that permits it to run engineering courses for women only or to reserve a quota of places for women on such a course.)

APPENDIX 5

TEACHING WOMEN SCIENCE IN THE HOME ECONOMICS AREA*

To investigate the effect of heat on protein

Two possible teaching approaches

Method 1: The traditional approach.

Method 2: Teaching approaches developed for women in Further Education – women with no previous science background and all having expressed anxiety related to the scientific elements of their courses.

(Level: City and Guilds Catering Courses (basic course).
Food and Nutrition 'O' level.
Home Economics 'A' level.)

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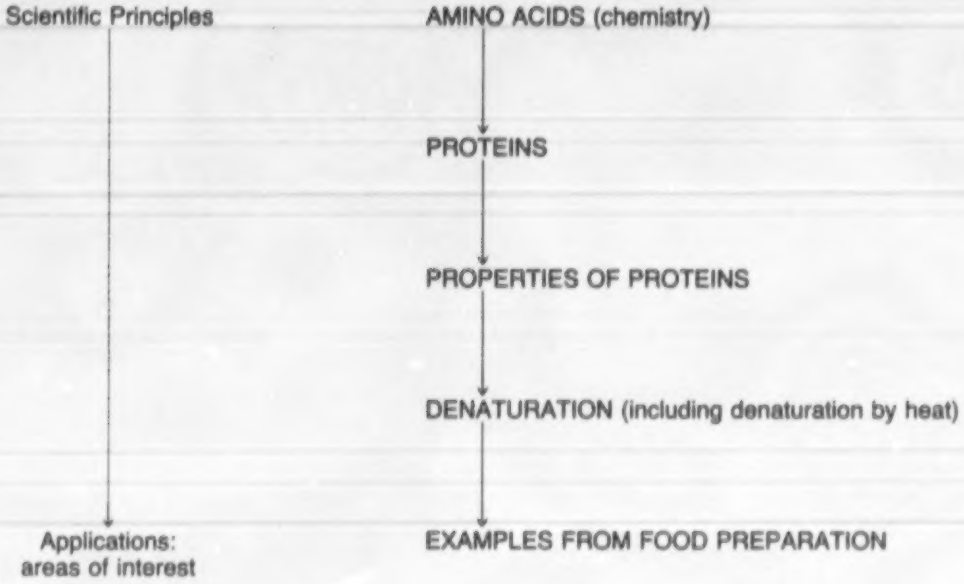
* The authors are grateful to Hilary Davies of Ilkley College who provided the material for this appendix.

DENATURATION OF PROTEIN BY HEAT

Teaching sequence

Method 1



DENATURATION OF PROTEIN BY HEAT

Teaching sequence

Method 2

Area of interest

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Scientific Principles

Boiled egg. Scrambled egg.
Cooked meat and fish. Boiled milk.
Discussion of changes which have taken place in cooking.

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Carefully constructed practical activities related to the examples given devised to encourage women to investigate the denaturation of protein by heat for themselves through familiar materials.

↓

Discussion: protein shape and structure (no formulae).

↓

Denaturation as distortion of molecule (diagrammatic representation).

↓

Cooking food.

The language of questions

Method 1:	The traditional approach. What is meant by 'the denaturation of protein by heat'? Explain the process using the effect of heat on egg protein to illustrate your answer.
Method 2:	Using the learner's everyday language. Scrambled egg thickens with heat. Name this thickening process and explain how thickening takes place using diagrams wherever possible.

Investigate the effect of heat on egg, milk and meat proteins

1. The effect of heat on egg protein

a. Put a little egg white into a test tube and heat gently. Note the temperature at which the clear albumen turns cloudy. (Is it as easy as it sounds? What are the problems?)

Repeat this experiment using egg yolk – this time noting the temperature at which the egg yolk thickens. Having done this compare your results with those given in the textbooks.

Compare your results with those of other groups. Can you discover some of the reasons why the denaturation temperatures vary?

b. Repeat the experiment this time adding half a standard teaspoonful of sugar to the egg white and the egg yolk samples. What effect does sugar have on the denaturation temperature of egg proteins?

What would be the effect of adding increased amounts of sugar to a cake mixture – recognising that a cake mixture is not protein but contains protein? What would you expect to see? Try this out and test your theory (hypothesis).

Make three one-stage cakes and bake under identical conditions.
Cake 1. Use the standard recipe.
Cake 2. Omit the sugar.
Cake 3. Double the amount of sugar given in the recipe.

Record any differences which you see during preparation. Note the cooking time and compare and comment on the result. Are the results as you predicted? What effect does sugar have on the denaturation of protein?

2. The effect of heat on milk protein

Heat a little milk in a pan and record the temperature at which the skin forms. Note too the temperature at which a deposit or 'fur' forms on the sides of the container.

Name the three main proteins found in milk. Which of these are denatured when milk is brought to the boil? Which proteins remain in the boiled milk? What is present in the 'skin' and what is the 'fur' found on the sides of the pan?

Using the textbook can you discover the proportions of each of these three proteins found in milk – in terms of the total protein content? In your view – is there a significant difference between the protein value of hot and cold milk? Discuss this together.

Is it possible to denature casein by heat? At what temperature? Could it happen even during domestic food preparation? Read.

3. The effect of heat on meat proteins

Heat a little raw minced beef in a pan of water, and note the temperature at which the colour changes from red to brown. At this temperature the blood pigment (haemoglobin) and the muscle pigment (myoglobin) are denatured.

The meat appears cooked at this temperature but would it be safe to eat? Compare this temperature with that considered to be necessary to destroy food poisoning bacteria. What implications has this for the cooking of meat?

Further Education Curriculum Review and Development Unit

Publications

Title	*Date Published*
Experience, Reflection, Learning – suggestions for organisers of schemes of Unified Vocational Preparation	April 1978
A Basis for Choice – Report of a Study Group on Post-16 Pre-Employment Courses	June 1979
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FEU/WMAC YOP survey in the West Midlands (available from the West Midlands Advisory Council, Norfolk House, Smallbrook Queensway, Birmingham B5 4NB. Price £3.50)	August 1980
Annual Report 1979-80	August 1980
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